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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE
INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

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A National Engineering Organisation.

There is a movement on foot to co-relate, or associate in some as yet undefined manner, the activities of the various engineering societies of Great Britain and Ireland. Already four of the most important—the Institutions of Civil, Mechanical and Electrical Engineers, together with the Society of Naval Architects, have formed a joint council, the objects of which are not too clear, but which are commonly supposed to be intimately associated with status. Last Friday, as announced in our columns, a meeting, headed by the Society of Engineers, was convened, at which the representatives of various national and provincial organisations were present. Amongst the matters tentatively put forward was an annual congress, where mining, sanitary, automobile, marine, metallurgical, and other engineers could meet together and discuss—platitudes, but little else. Another suggestion was a tome to contain the proceedings of these various societies. If the scheme is well supported, and, say, half the 200 engineering and kindred societies of Great Britain become adherents, then, assuming each constituent member has eight meetings, and each meeting only takes up ten pages, it would produce a book of no less than 8,000 pages. The value of the book when finished, no matter how prepared, would vary indirectly with the size. However, a committee of seven, which includes a representative of the Women's Engineering Society, has been drawn up to formulate a constitution, which is to be submitted to the societies concerned. Is the Institution of British Foundrymen concerned? Would an association such as this help in the co-operation between the drawing office, pattern shop and foundry? We doubt it. Would it give the foundryman such a knowledge of the various branches of engineering that it would help him to produce better and cheaper castings? This, again, is doubtful. Conversely, is engineering going to benefit by the inclusion of foundrymen in any national scheme such as can be visualised? Here, again, doubt exists. We are prepared to hear from the supporters of the scheme that such systems have been successfuly operated in Austria and Germany. But between Great Britain and Germany a basic difference is in existence. Every engineer in Germany, to earn the title, must have a college training. Just as it is practically impossible to become a medical man by working as a dispenser in the day time and study medicine at evening classes in this country, so in Germany it is practically impossible to earn the title of "Ingenieure" by part-time study. Thus all "engineers" are of the same standing. In this country, which has been an industrial State for several generations, there has grown up a system of evening classes in most of the largest centres, which undoubtedly can impart to a willing student in five or six years exactly the same knowledge as is given to a day student in three or four years, thus breaking down the Continental conception of an engineer. The advantage always rests with the hard-working evening student because his theory is reinforced by practice.

It was emphasised at the meeting that a national association of engineers could speak to the public with one voice. We have yet to learn that engineers, as Britishers understand the word, ever can speak with one voice. There is little community of interests between marine and mining engineers or between automobile and water engineers.

Another feature in favour of the scheme is the standardisation of material and specifications for their acceptation. At the moment this work is adequately tackled by the Engineering Standards Committee, which is always only too anxious to co-opt representatives from interested societies.

There is just one feature, which perhaps looks attractive on paper; that is, a scheme may be evolved whereby a member of an affiliated society could visit the meetings of all other affiliated societies. In practice, if a person wishes to attend a meeting of a technical society of which he is not a member, he can usually be introduced.

Finally, does the British mentality, which has evolved some 200 engineering and allied technical societies, really require that they should be co-related? We admit that the Football Association has done much for Association football, but the Rugby Association still flourishes. We are prepared to support any scheme for the co-relation of mechanicals, electricals, civils, or any other type of engineering separately, but not a general council embracing the whole. Each branch of engineering in this country is sufficiently large to cater adequately for its own national technical needs.

Institution of British Foundrymen.

LONDON BRANCH.

The first meeting of the Session was held last Thursday at the Institute of Marine Engineers. The chair was taken by the retiring President, Mr. H. O. Slater, who congratulated the Branch on the excellent choice of a president. In Mr. W. Lambert they had combined all the necessary attributes of a president. He was both a ferrous and non-ferrous metallurgist. He had travelled extensively, which endowed him with that broadness of vision so desirable in a president. Lastly, though a man of considerable scientific attainments, he had the happy knack of making abstruse subjects appear elementary. He then called upon Mr. Lambert to deliver his presidential address, the title of which was "Metallurgy and the Foundry."

Mr. Lambert then delivered the following address:—

PRESIDENTIAL ADDRESS.

Metallurgy and the Foundry.

Mr. Slater and Gentlemen,—I am deeply sensible of the honour of being placed in this chair as President of the London Branch of the Chartered Institution of British Foundrymen. My pride is greater because I recognise that the occupancy of this chair is no sinecure. The London Branch of the I.B.F.—thanks to the indefatigable energy and personality of our hard-working Hon. Secretary, Mr. Faulkner—is, to-day, very much alive, and it is my intention, health and circumstances permitting, to do my utmost to further the interests of this Branch.

In view of the fact that the proposed Annual Convention of the members of the Institution as a whole may after all very possibly be held next year in this city, your officers and Council—and in parentheses I may say that no Branch of any parent Institution in the United Kingdom has a more loyal, genial and enthusiastic Council—your officers and Council are particularly desirous of enthusing every one of the members of the London Branch to big efforts during the next few months, so that this Branch may possess that degree of dignity, strength and courage which may well cause envy in the breasts of the officers of all the visiting Branches.

We want to enrol a number of new members, and to rope in all such as are qualified and desirable. I use the word desirable in its broadest sense. We must not forget the honour which has been conferred on the Institution by the granting of a Charter by His Majesty King George V., and it behoves us each and all to preserve the dignity of our Branch, and at the same time to promote the intellectual welfare of the members of the Branch in accordance with the objects of the Institution as set forth in the Royal Charter.

I have attended almost every meeting of the Branch and also the Council meetings held during the last twelve months, and I am very pleased to bear testimony this evening to the zealous energy of those gentlemen who hold office or serve on the Council. The Branch generally owes them each and all a debt of gratitude for their self-sacrificing efforts, and for the many attendances at the Council meetings, the latter often at very considerable personal inconvenience.

Reverting to my previous remarks relative to my occupancy of the Presidential chair for the ensuing year, it is not within my knowledge whether, as a metallurgist, I am the first member of my profession to have the honour of being placed in this position, but I must confess to having had a little compunction in accepting the position of Vice-President a year or so ago, foreseeing as I did that the time would probably come when, in the ordinary course of events, I should be proposed to this Chair. I felt that to take the office referred to was to some extent usurping the throne of the Foundrymen, inasmuch as I am not a full-blooded foundryman in the restricted sense, but only a works metallurgist. But after all, what is a metallurgist, and in what relation should he stand to the foundry industry?

What is a Metallurgist?

The shortest definition I can offer is, one who is learned in the science of metallurgy. This definition does not take one much farther unless we arrive at the definition of the word "metallurgy." Metallurgy may be defined as the science of metals—comprising the processes for the extraction or winning of metals from their ores, and for rendering such metals suitable for use in the arts and crafts; likewise the processes involved in working such metals, and the determination of the physical and mechanical properties of each metal. Further, the processes involved in the compounding together of two or more metals or of metals with non-metallic elements, and the study of the properties and application of such complex bodies.

The works metallurgist must be a trained observer and an experimentalist. He must be able to bring a keen, analytical mind to bear upon shop problems; he should possess imagination and be able to reason by induction. Constructive criticism rather than destructive criticism should be his motto.

Roll of the Works Metallurgist.

Secondly, in what relation should the works metallurgist stand to the foundry? The works metallurgist should be regarded as having a position comparable with that of a King's Counsel—working with a brief one day for the employer, and on another day with a brief for the foundry foreman, but never assuming the rôle of a criminal detective or that of a policeman. He must at all times be able to command and hold the confidence and respect of both his principals and the works staff.

It may be of interest if I just recite a list of the subjects in which a student must qualify to obtain the Diploma in Metallurgy of the Royal School of Mines, at South Kensington:—Chemistry, physics, mathematics, mechanics, applied mechanics, applied electricity, geology, metallurgy—ferrous and non-ferrous, assaying—ferrous and non-ferrous, metallography, electro metallurgy, hydro metallurgy, ore dressing, physical chemistry, machine drawing, furnace drawing and design, refractory materials, fuel, mineralogy and graphs.

I do not believe that the workshop is the only school in which to receive a training, but I certainly am firmly of opinion that the works metallurgist who is content to assume that his college training is the alpha and omega of his profession, and shuts himself up in the works laboratory will never make an ideal works metallurgist.

An intimate knowledge of the details of works practice, and, if possible, a greater knowledge of human nature, gleaned from close association amongst the craftsmen practising the arts and crafts of metallurgy, is most essential if one bids for success as a works metallurgist.

To ask, Why do you want to know? before answering a question, too often causes an inquirer to close up like an oyster; whereas, a willing reply by the one addressed will, more often than not, lead to an open confidence, resulting, frequently, in mutual benefit to both parties. With children even, one may often notice that if, when a question is put, it is met with the words, "Why do you want to know?" the child replies, "Oh! it doesn't matter, I only wondered"; maybe, what might have proved an interesting confidence has been nipped in the bud.

The Workshop of the Metallurgist.

The workshop of the metallurgist is known as the laboratory. The works laboratory should not be a closed department so far as the foundry foreman is concerned. He should be encouraged to seek the co-operation of the laboratory, and the foundry foreman on his part should endeavour as far as possible to keep the laboratory in touch with both the successes and the failures in workshop practice. Mutual confidence must be established if the best output is desired.

I am quoting from a leading article of one of the contemporary engineering journals. "We must take the Institutions as we find them, and admitting that they fall in some measure from perfect grace, we cannot but recognise that even the Institute of Metals would benefit by occasional elementary lectures on the principles of the relatively new science of metal."

If the Institute of Metals, so also the Institution of British Foundrymen, and, if the Institu-

tion as a whole is to benefit, it can only do so through its individual members. Therefore, I am optimistic enough to believe that the London Branch will welcome occasional elementary lectures on the principles of the relatively new science of metal.

What is a Metal?

Has each one present here this evening ever put pen to paper and tried to write out the definition of a "metal"?

What is a metal? Surely you will agree that this is quite an elementary question, and yet, after thirty years intimate association with "all sorts and conditions" of metals, I confess to being unable to give a really satisfactory definition of the word "metal." One authority has written: "The term metal is more convential than strictly scientific"; the word, therefore, does not permit of a strictly accurate definition.

Over sixty metals are at present known, yet as recently as the days of good Queen Bess, only seven metals were known. This statement alone gives some idea as to what we all owe to the scientist. The possible number of combinations which can be provided by compounding together two or more of these elementary metals in varying proportions is impossible to calculate.

What exactly is one to understand by the principles of the relatively new science of metals. To answer this query in anything like a sufficiently comprehensive manner would take many hours, and a far better exponent than myself.

However, I propose to attempt to enumerate briefly and in simple language one or two of the more recent methods of investigation which have been employed to advance the science of metallurgy, and to enable the principles of the relatively new science of metals to be propounded.

Microscopy.

This word is derived from the Greek "micro," small. The study of the small structure of material. You are all familiar with the reproductions of photomicrographs showing the microstructure of metals and alloys. Almost all the present-day literature on metallurgical subjects has its pages interspersed with micrographs. Several members among us this evening are expert metallographists. The value of the information gleaned from a study of the micro-structure of a metal or alloy is nowadays recognised without question. Do you realise that this method of investigating certain characteristics of the metals and alloys was only established two or three decades ago (1894).

For the microscopic examination of metals, the surface of a suitable section of the metal is brought to a fine finish by either filing, grinding, or the use of various grades of emery and other abrasives mounted on cloth or paper, and is then prepared for examination by one or other of the following methods:—

Bas Relief.—In which the softer constituents are worn down, and the harder are left in relief.

Polish Attack.—Combining both bas relief polish and attack by a weak etching medium.

Electrolytic Etching.—The specimen being placed in an electrolyte—a liquid which will conduct an electric current—the surface of the specimen can then by suitable means be either eaten away in parts or plated in parts, which serves to differentiate between the various constituents.

Heat Tinting.—By which colour variations of the surfaces of the constituents are produced, which effect is brought about by the degree of surface oxidation due to the time and the temperature to which the specimen is exposed.

Tarnish Effect.—The degree of discolouration of the constituents when the surface of the prepared specimen is exposed to certain gases such as sulphurated hydrogen (H_2S.).

Other methods suggest themselves, and are occasionally used, but need not be enumerated.

In view of the fact that metals, unless in extremely thin sheets are opaque to light, it is necessary to examine the subject either by oblique or vertical lighting, and in order to explain to the uninitiated the *modus operandi* by which the microscopic examination of an opaque object is possible, microscopes and diagrams have been brought to the lecture hall, and each one of you can have a personal demonstration.

The next question is, what does the microscope reveal? It shows us (1) Grain size and characteristics of the grain, such as core effects, etc.; (2) the structure (phases); (3) constituent metals when occurring uncombined; (4) segregations; (5) foreign matter; and (6) crystal cleavages, inter granular porosities, gas holes, slip bands, etc.

Macroscopy.

This word is derived from the Greek "macro," large. The study of the coarse structure, etc., of material. As in the case of the examination of the micro-structure, it is necessary to have a prepared surface, but in this instance the surface, if a polished one, will not require to be finished to anything like the extent of that required for microscopic examination. The prepared surface is then either eaten into by an etching reagent, or by the abrasive action of some specific medium used under pressure. Heat effects on the surface, and also tarnish effects may likewise afford a means of differentiating and identifying certain constituents or segregated masses.

In the first method, the structure developed, results from the relative degree of solution of the various constituents in the etching fluid. In the second, it is the selective resistance to the action of abrasive which serves to distinguish between the constituents, and in the third method it is the relative rate of oxidation, and the depth of the oxide films produced on the surfaces of the various constituents which serves as a means of identification. In the fourth case, it is the discolouring effects of certain reagents when applied at normal temperatures.

Pyrometry.

The thermo-electric couple, or more simply the thermo couple, was discovered by Serbeck in 1822, but remained dormant until revived by Le Chatelier in 1886.

The junction of any two dissimilar metals when heated is the seat of an electromotive force, which is approximately proportional to the temperature. If we unite together one end of each of two wires and connect the free ends to a delicate electrical measuring instrument—a galvanometer—then, upon heating the junction of the two wires, a movement on the indicator of the instrument can be observed, and if the scale of the instrument is calibrated to read in terms of temperature, we have at our disposal a very valuable thermometer.

The great virtue of the thermo-couple for scientific research work lies in the fact that the mass to be heated is exceedingly small. The E.M.F. (electro-motive force) generated at the junction by heat is a function of the chemical composition of the two wires, of the dissimilarity of the two metals, and not of the gauge of the wire. For high temperature determinations it is, of course, necessary to select suitable wires. The most satisfactory thermo-couple for high temperature measurements is made by joining together a pure platinum wire with one of a rhodium-platinum alloy (90 per cent. Pt + 10 per cent. Ro).

Pyrometers of the thermo-couple type are used almost exclusively in observations connected with physico-metallurgy. Recording instruments giving an autographic chart are in common use with the type of thermo-couple mentioned above, and the two in combination afford a very accurate, and at the same time fairly robust scientific instrument.

The use of the thermo-couple pyrometer for researches in physico-metallurgy, and the application of the microscope for the examination of metals, may be said to be the two predominate factors making possible and leading to the introduction of the newer science of metallurgy.

Utility of Pyrometry.

Amongst other determinations, with the thermo-couple, one can make:—

(1) Accurate determinations of the melting points (freezing points) of each of the elementary metals.

(2) The thermal effects taking place during the transition from the wholly liquid to the wholly solid states and *vice versa* of the alloys.

(3) The thermal effects taking place in solid alloys when cooled from above or when heated above or cooled below the normal temperature.

Finding Melting Points.

If we immerse a thermo-couple, suitably protected, into a small molten mass of an elementary metal such as pure copper or iron, and remove the molten mass from out of contact with the source of heat employed in melting the same, the

metal will gradually cool down, and the indicator connected with the thermo-couple will continue to show a steady fall in temperature until the moment that the mass commences to solidify, when an appreciable arrest of the movement of the indicator will be observable, and not until practically the whole of the mass has solidified will any considerable further downward movement of the indicator be apparent. The scale reading at which the arrest occurs, if the instrument has been accurately calibrated, will represent the temperature of freezing of the metal—the freezing point. With all pure elementary metals, the freezing point and the melting point are identical. Pure compound metals and eutectic alloys behave as elementary metals in so far as showing a single "arrest" only, namely, at the freezing point.

With an open scale on the indicator and a series of pure metals of known melting point, covering a sufficient range, it is of course easy to calibrate an instrument for oneself by a careful observation of the arrest points of the metals constituting the series.

Liquid to Solid Thermal Changes.

As an example of the thermal changes taking place during the transition from the wholly liquid to the wholly solid state, and *vice versa*, of alloys, we may take an alloy of lead and tin. All alloys of lead (328 deg. C.) and tin (232 deg. C.) are homogeneous liquids at any temperature above the freezing point of pure lead.

When the two metals lead and tin are compounded together, it follows from the foregoing statement that the mixture will be a wholly molten homogeneous mass above a temperature of 328 deg. C. Alloyed in the proportion 27 lead: 63 tin, the freezing point is lowered to 182 deg. C., and a cooling curve of this alloy shows only one arrest in the fall of temperature during the transition stage from the liquid to the solid state.

Compounded in certain other definite proportions, two arrests are observable, before the metal becomes wholly solid, the first at which crystals are formed, either rich in lead or rich in tin according to the increase in the percentage of one or other of the two metals above the figures previously given, namely, 27 lead: 63 tin. The second arrest will occur when the *liquid metal still remaining* has arrived at the proportion of 27 lead: 63 tin, when the metal will solidify without further fall of temperature until the whole mass is set.

The mother liquid from which are deposited the lead-rich crystals or the tin-rich crystals, as the case may be, is termed the *eutectic*, and is the alloy of the lowest freezing point of the whole series of alloys, and this property being peculiar to itself, it follows that the eutectic alloy has an invariable composition.

Thermal Changes When Solid.

As an instance of the thermal observations which may be made during the heating or cooling of a solid metal, one may quote the phenomena occurring when a piece of high-carbon steel is heated to or allowed to cool from a full red heat. If we take for example a piece of carbon steel with, say, 0.9 per cent. of carbon, and insert our thermo-couple in the mass, we shall find that on heating the metal up to or cooling from a full red heat, a very appreciable "arrest" occurs at a temperature range in the neighbourhood of 700 to 750 deg. C., the precise figure depending upon the composition of the steel.

Now, we are in a position to go a step further, and by studying the equilibrium diagram or constitutional diagram representing the compounding of two or more metals to form a series of alloys, we may get an insight into the most comprehensive and satisfactory method of describing the nature and constitution of the alloys of a given system.

Unfortunately, time will not permit this evening of our constructing an ideal constitutional diagram, for even a simple two metal system, but if so desired I shall be pleased on a subsequent occasion to carry you somewhat further into the study of the constitutional and other diagrams.

The thermal analysis of metals and alloys, comprising as it does the melting and freezing points, solidification ranges, critical temperature points and ranges during which transformations in structure are taking place, has been very materially aided by the employment of electrically-heated furnaces. By far the greater amount of investigation work in connection with the thermal analysis of metals and alloys has been conducted in electric furnaces of the laboratory type.

The Electric Furnace.

In its simplest form the furnace may be described as a tube around which a metallic wire of a suitable metal is wound, and through which a current of electricity is passed. The wire becomes heated, and in turn heats the tube upon which it is wound. The wire wound tube is lagged with refractory material of low heat conductivity, such as magnesia, quartz, sand, etc. In other types of electric furnace, the material of the tube itself is the resister. The bore of tube affords the heating chamber in which the metal to be examined is placed. Crucibles can be introduced into the tube, and serve as a means of containing molten metal.

The great advantage of the electric furnace over all other types lies in the facility with which one is able to effect control of the temperature, and this, coupled with the cleanliness, compactness, and convenience of the electric furnace, makes it an almost indispensable adjunct to the laboratory.

The thermal treatment of metals as practised in the heat treatment of steel, the bronzes, and in practically all the metals and alloys used in engineering, and covering such processes as normalising, hardening, annealing, tempering, case-hardening, etc., owes much of its present-day application as a result of laboratory research, in which the microscope, pyrometer, and electric furnace have contributed invaluable aid. In hundreds of instances it is now possible to prognosticate with certainty the results to be expected if a metal or alloy is subjected to a particular process of heat treatment.

Magnetic and electrical phenomena as exhibited when metals are subjected to various treatments is not neglected, and the significance of such phenomena not only from a purely academic but from a practical point of view is carefully studied. Electrical measurements play an important part in the newer science of metallurgy, and many are the ingenious instruments employed in this class of work.

The use of X-rays as a means of examining the homogeneity of a metal must not be allowed to pass without mention.

Testing Machinery and Mechanical Testing.

The mechanical tests with which everybody connected with the metallurgical industry are best acquainted are the tensile or pulling test, the transverse or bending test, and the compression or squeezing test. These three tests have long been established, but notwithstanding this fact, every day introduces further refinements in the mechanism for conducting these tests and analysing the results obtained. To enumerate the whole of the newer testing processes would be to tax your patience perhaps unduly, but mention must be made of the more important introductions such as the single-blow impact testing machines of Frémont, Izod, Guillery, Charpy and others; the repeated blow impact test with machines of the Eden Foster and other types; repeated bending test with machines of the Sankey and the Humphrey type; hardness determinations as by the Brinnel and the Schore apparatus; tests to determine the resistance to abrasion; torsion tests; shearing tests. Even a revolving emery wheel is not despised, as evidence the "spark tests" of carbon and alloy steels. The cinematograph also has been called into service, and films have been taken showing the behaviour of test bars under varying conditions of mechanical stress.

I am afraid I have only too inadequately put before you this evening some of the things which I had in mind when drafting these notes, but I can assure everyone here this evening who has not already delved into one of the more modern treatises dealing with the newer science of metals, that the sooner he does so, the sooner he will appreciate the advance the science has made during the last few years. If read in the right spirit the subject is a most fascinating one, particularly so to the man who is daily making use of the metals as materials of construction.

In conclusion, I offer my humble services to any member of the Branch to whom I can render assistance in recommending suitable text books, or in elucidating any of the knotty points he may come up against in the literature appertaining to the newer science of metals.

Demonstration.

The President after exhibiting and explaining a large number of slides illustrating chemical, physical and mechanical testing, left the platform and demonstrated in a very practical manner a large quantity of scientific apparatus brought from his home and lent by Messrs. J. Stone & Company, Limited, of Deptford.

The Chairman said it was not usual to discuss a Presidential Address, but he invited all present to inspect the apparatus provided by the President at the close of the meeting. With regard to pyrometers, he had had a good deal of experience in the annealing of malleable iron, etc., and he had always considered that his eye was good enough to enable him to tell the temperature of a metal for practical purposes. He had relied on practical experience a great deal, but that was probably because he had not properly understood the pyrometer.

Vote of Thanks.

The Secretary, in proposing a hearty vote of thanks to the President, said that the lecture had been most interesting. To him it had been a case of the revision of what he had learned at the University. If he himself were asked to judge a temperature, he would look round in order to visualise the amount of light in the particular shop, because workshops differed tremendously in regard to the amount of the light in them. There was good lighting in some, and practically no light in others, and that would influence the eye tremendously; he had great confidence in a man's eye, provided he was always on the same job. If a man were taken from a well-lighted foundry to a badly-lighted one, and asked to estimate the temperature of a metal, he would probably be at least 100 deg. C. wrong. A man could work very well without a pyrometer for weeks or months, and then, through health considerations, he would go wrong; a man's eye wanted calibrating every three months, or less, depending on the constitution of the man. That was where the value of science came in. Science was absolutely essential, but, at the same time, many professors nowadays made a serious error. They would take a system of two metals and cast alloys ranging from 1 to 99 per cent., mix them up very nicely, and then cast ingots. But it did not matter whether they were impossible castings, or good ones, because they were part of the research, and the results were published. The old-fashioned professors, if they did not make good castings initially, they would discard them and say that if they were not good enough for commerce then they were useless for research. Unfortunately, it was found nowadays that many professors had no practical training. If a practical man asked what was the practical bearing of a particular piece of work—although admitting that it was interesting from the theoretical point of view—they were afraid to make a hazard. The professors were just as frightened of the practical men as the practical men were of the professors, and if a practical man told a professor that the results of an experiment in practice were different from the theoretical results, the latter would doubt his own results. Therefore, it was time the various grades co-operated—practical, technical and academic. It was possible for the academic man to become technical and for the practical man to become technical. Here they could meet on common ground for the general good of the industry.

Mr. J. Ellis seconded the vote of thanks. The best thanks of the Branch were due to Mr. Lambert for having brought so much apparatus for their inspection. It must have cost a great deal of time, money and trouble to have prepared the lecture in such a manner that it could be understood easily by the members. He quite agreed with Mr. Faulkner as to the academic gentleman and the practical man. That was the essence of the existence of the Institution of British Foundrymen. The practical men started it, although some of the professors liked to say now that it had its birth at the University of Birmingham; that was not so. It was started by purely practical men, and their object was to try to teach the academic gentlemen; it was not so much for the academic gentlemen to come and teach the practical men, because, after all, the academic gentlemen have never made a good casting. Practical men have made many wasters, but they have made a great many good castings. But the time had come, he said, when the practical men were being recognised, and the academic gentlemen were coming amongst them and giving them the benefit of their knowledge, if the practical men, on the other side, would give the academic gentlemen the benefit of their knowledge. It was only by the combination of the two that the true results for which the Institution of British Foundrymen was working would be achieved.

The vote of thanks was carried with acclamation.

The President's Reply.

The Branch-President, in thanking the members, referred to Mr. Faulkner's remarks. He (the President) did not pose as an academic man; he had been a humble works metallurgist for the past 30 years. He had found that scientific apparatus was of use to him, and he had done his best to introduce such apparatus, where he considered it was necessary, into the workshop—he would not say to try to educate the workshop man, but to try to lead him to regard scientific apparatus, not as being something which he could not understand anything about because he had not been scientifically trained, but as an adjunct to his work. There was no doubt that the time had come when pyrometers had got to be used. It was all very well for Mr. Slater to say he had confidence in his eye, and that he knew when a metal was at a temperature of 1,000 deg., but he must have had some instrument in the first place with which to measure it; otherwise, how would be have known that it was 1,000 deg.? He was very delighted to have given his lecture, because he wanted to drive away the bogie of what foundrymen called science. There was no bogie about it at all. They must take it in their hands and grasp it, get hold of good books on the subject, and try to understand it. If they came across knotty problems which they could not follow, he would be pleased to help them to elucidate them if they would come to him. There was a fascination about foundry work, and some of his happiest moments had been spent on the stage of a steel furnace; if foundrymen would study the application of science to the foundry, they would find that there was a great great deal more fascination in it than otherwise. As illustrating the relations between the academic and the practical man, he said he had called upon an academic man some time previously, who had shown him a valve casting made in aluminium bronze, and told him that it would stand a test up to 2,000 lbs. He had asked the academic man how many castings he had made before he had obtained the particular one referred to, and was told that he was the first man who had asked that question.

Forthcoming Events.

OCTOBER 5.

Institution of British Foundrymen (London Branch):—"The Manufacture of Locomotive Superheater Cylinders," by A. F. Gibbs.

OCTOBER 7.

Institution of British Foundrymen (Lancashire Branch):—Ordinary meeting at Manchester. Presidential address by John Haigh (Branch President). "The Handling of Foundry Materials," Paper by Mr. Haigh.

Institution of British Foundrymen (London Branch):—Visit to the works of Messrs. Fraser & Chalmers, Erith.

OCTOBER 10.

Institute of Metals (Birmingham Local Section).—Address by F. Johnson, D.Sc. (Chairman).

Institute of Metals (Scottish Local Section).—Meeting at Glasgow. Address by James Steven (Chairman).

Sheffield Association of Metallurgists and Metallurgical Chemists:—Ordinary meeting at Sheffield. "Atomic Structures," Paper by J. Woolman, M.Sc.

OCTOBER 11.

Institution of Automobile Engineers:—Presidential address by Lt.-Col. D. J. Smith.

OCTOBER 12.

Society of Chemical Industry (Bristol Section):—Ordinary meeting at Bristol. "The Importance of the Chemist to the Nation." Address by Dr. E. F. Armstrong.

Institute of Metals (London Local Section):—Address by D. Hanson, D.Sc. (Chairman).

OCTOBER 13.

Institute of Metals (Sheffield Local Section):—Postponed annual general meeting at Sheffield University, followed by Paper on "Non-ferrous Foundry Practice," by P. Longmuir, D.Met.

An Apprenticeship Course in Foundry Practice.—XII.

By Ben Shaw and James Edgar.

METHODS USED IN PATTERN CONSTRUCTION.

PART I.

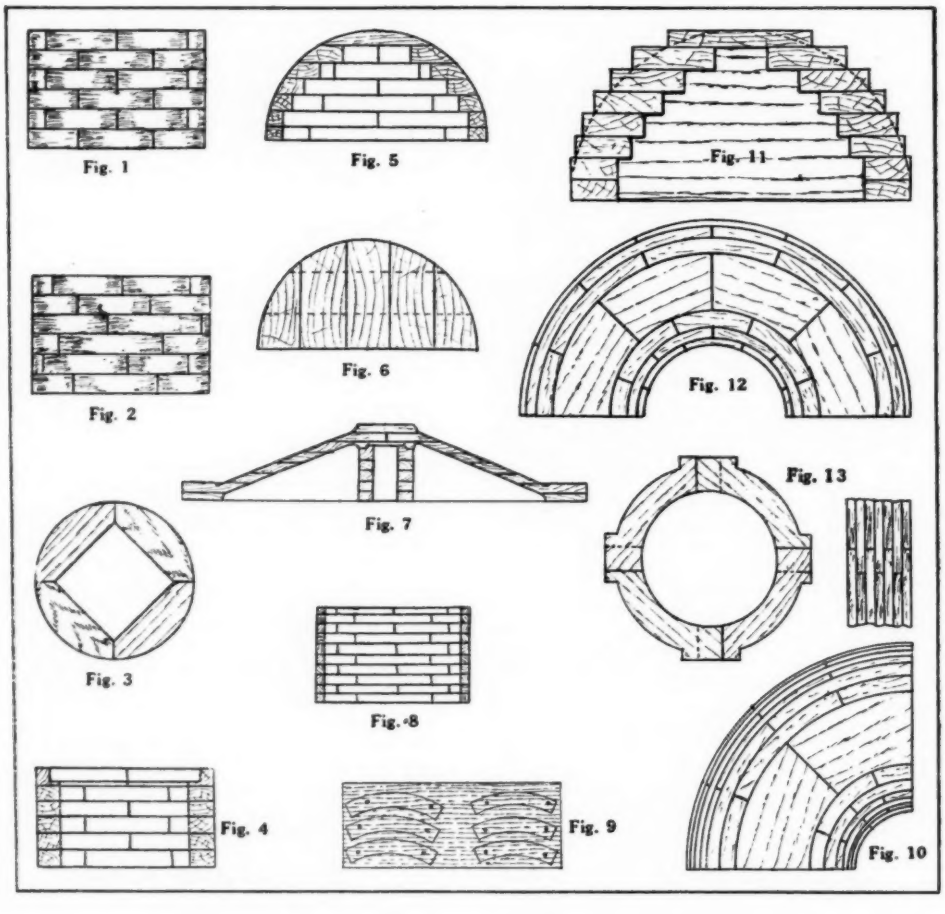
With small work the patternmaker may have no choice as to the method of construction adopted, unless it be a question of using a block print as an alternative to a loose piece, but with nearly all jobs, apart from details, it is possible to construct them by various methods, and judgment based on experience and skill can alone determine which is the best method to adopt. There are several important points to be considered before the work is started. The number of castings that are required should always be borne in mind, because it is obviously absurd to make a flimsy pattern, suitable for a one-off job, when the pattern will be used over a long period, and it is likewise wasteful to adopt expensive methods of construction if only one or two castings are required. It is, however, sometimes necessary to make an exceptionally good pattern because of the foundry being a considerable distance away, rendering it difficult for the moulder to consult the patternmaker or to get the pattern repaired, in the event of an accident. Foundry equipment has also to be considered. It is futile to supply loam boards for a cylindrical job to a foundry that has no equipment for loam work. It is not unusual for foundries to return patterns to be altered, or even reconstructed, because they have not been made so that they can be moulded with the tackle available, and especially is this true of large work.

All patterns should be designed with a view to the elimination of hand work as much as possible. This is a policy which is resented by many craftsmen, but it is possible, within the limits imposed by such a principle, to be an artist, and the apprentice should remember that the lower the production costs are, the better it is for the industry Any advantage that may be gained by making a pattern more costly than is necessary is only a temporary one. We have known men carve work at the bench when it could have been turned in the lathe in a fraction of the time. When choice is possible, work should in nearly all cases be turned.

Grading Work.

We shall not discuss the constructional details of specific patterns in this article, but what may be termed standardised methods of construction. Some jobbing pattern shops grade work according to quality, to assist them in tendering, and it is usual for the patternmaker to form a habit of grading his work whether or not it is shop practice. It is possible to make three qualities of most large patterns and two of small patterns. A good example of grading small work is the jig pattern in the motor-car shop, as compared with a pattern of, say, the engine cylinder. One casting will be required for the jig, whereas hundreds will probably be required from the cylinder pattern; therefore not only a cheaper quality of timber can be used, probably second or third quality yellow pine instead of baywood, but the filleting of sharp corners can usually be left to the moulder. If, however, a large number of castings were required from the jig pattern it would be an economy, because of the saving of the moulder's time, to construct the pattern with all fillets, even if the degree of accuracy were not so important.

If we divide patternmaking into three classes, the cheapest is the skeleton pattern, and the other two may be graded to form first and second quality patterns.



Standardised Methods.

Skeleton patterns form a distinct class by themselves, and we shall deal with them in a special article, confining ourselves in this article to a description of the principles of lagging, staving, boxing up and segmental construction. The methods adopted in these operations are dependent, to some extent, on the quality of pattern desired, because, when a one-off pattern is being constructed, lighter timber can be used and methods of jointing which involve less labour. Details of construction are also modified, according to the quality of pattern required, but this will be best appreciated when we come to discuss building patterns. A word may not be out of place here about shell patterns. In some patternshops there is a strong prejudice in favour of shell patterns—that is patterns that leave their own cores. Much depends on foundry conditions, and also on whether a shell pattern can be more easily moulded than a block pattern and corebox; a strong argument for the shell pattern is that the correct thicknesses of metal are assured. Patterns which are required to be fitted to boilers, condensers, etc., are frequently required to be exact models of the desired castings because, after they have been fitted in place, the engineer in charge is responsible for determining the position in which the casting is to be finally located and a pattern similar in shape to the casting is more helpful.

In constructing medium sized and small cylindrical patterns, there is often a choice possible as between lagging, otherwise called staving or segments. Unless a pattern body is small it is always best to build it rather than make it from solid timber. A circular pattern may then be made as a lagged barrel, or, if it is short in length, in proportion to diameter, it may be built of laminæ of segments. An important advantage of lagging is that if the grounds to which the staves are fastened are carefully made, it will last for a very long time and, if for vertical moulding, will deliver freely from the sand. With a lagged cylinder there is no crossing of grain, but, when segments are used, the periphery does in time become somewhat irregular, and thus tears the mould. For short cylindrical bodies or parts which have to be fitted to a main body, the segmental method is generally preferable. There are exceptions of course. Segments can be quickly sawn and built. It is good practice to stave work that is of greater length than diameter.

Segmental Work.

For shapes that are irregular, or that have to be recessed in places after the work is turned, the segmental method is preferable, because the segments can be made wider locally to allow for the cutting. A much stronger pattern is made of two thicknesses of segments than by a one-thickness plate. It is not always possible, as in ordinary timber jointing, to glue "back to back"—that is with the annual rings tangent on the joint—but it certainly should be done when there are only two laminæ of segments, to ensure against warping.

Short segments are more satisfactory than long segments, although it is not advisable to make them too short, especially if there is not sufficient lap between one joint and another; on the other hand, long segments expose end grain as well as side grain to the atmosphere, and thus the periphery in course of time tends to become more irregular. Strength, and permanence of form, can only be secured by the use of segments which give an almost continuous grain, and, while the number of segments to the circle should be determined by the diameter of the work, as a general rule it may be said that they should not be more than 12 in. to 15 in. long.

If a casting pattern is wanted, and it is intended to paint or varnish it, the segments should be glued, and, although driving nails are satisfactory for general work, two-thickness jobs should invariably be screwed.

There is much difference of opinion amongst patternmakers as to whether symmetrical or staggered joints are the better. As far as appearance goes, although this should have no bearing on the matter, the job which is built with the joints of alternate courses in the same perpendicular lines looks more artistic, but it is a mistake to suppose there is no case for staggering joints. Those who advocate staggered joints urge that greater strength is obtained when no two vertical joints are in line. Too often, no proper system is adopted, nor is sufficient care taken in marking off the segments of varying lengths, hence a very weak pattern may be made. There is no real case against jointing, such as is shown in Fig. 2, and it is worthy of careful comparison with that shown in Fig. 1. We prefer symmetrical jointing chiefly because short and weak laps may be made, unless great care is taken, and thus the very object aimed at defeated, which is to secure strength by not having any two joints in the same vertical line.

Although for large work thicker segments may be used $\frac{7}{8}$ in. or 1 in. is as thick as ought to be used for the majority of patterns, and in many cases much thinner segments are advisable. Fig. 3 illustrates the diagonal cutting of segments on the inside, which is often resorted to, and which results, in many cases, in a waste of timber without any appreciable addition of strength. Two to two and a half inches is as wide as it is necessary for segments to be made, as a general rule, and for small work they may be narrower than this, and, unless the boards are so narrow that only one segment can be cut from the width, they should not be sawn as at Fig. 3.

If for any reason it is necessary to close the end of a segmentally built cylindrical pattern, it is bad practice to screw a plate on top of the segments and unnecessary to build the last two courses into the centre. The best way is that shown in section at Fig. 4, which consists of turning a recess in the last course of segments and inserting a plate which may be either sawn or pared. An alternative way to turning the recess is to secure the plate before the last course has been attached, and fit this row of segments against it.

Figs. 5 and 6 show alternate methods of building a dome, Fig. 5 being a section. The method shown at Fig. 6 is very suitable for patterns that are rather small to be segmentally built. The more common, but less satisfactory method is that indicated by dotted lines in Fig. 6. Often in building such a dome segmentally the segments are left needlessly wide to safeguard against weakness. The layers of segments should be set down on the drawing board and the diameters transferred, as the building proceeds, to the building board. The top of the dome should be in baywood, or other hardwood that shrinks less than pine.

It is not always possible to use nails in segmental work. Pegs have frequently to be used. Holes for them are bored with a pin bit, and the pegs, made square, are dipped in glue, then driven in. Fig. 7 represents a large valve cover. It would be very awkward to nail this job as, with the greatest care, nails will sometimes follow the grain of the timber, and then there would be endless trouble when turning, owing to the points of nails coming through. Some men are content to bore perpendicular holes to receive wood pegs, but a much better result is obtained by boring the holes at the angles. Such a pattern as this ought to be thoroughly dry before it is turned. It will be observed that the centre boss in the sketch has been built and turned separately, which is much easier than building the whole job at one operation. Thin segments are better for such a job as they are easier to peg. Sometimes, when building a thin and deep ring, similar to Fig. 8, reliance has to be placed entirely on the glue, which should be applied thin and hot. In ordinary building very little planing of the joint should be necessary if the planing machine and trimmer are in good condition, but, when neither nails nor pegs can be used, each course should be carefully planed to ensure a good close joint.

When making a saucer shaped pattern, similar to Fig. 7, as only six segments of each size are required, they may be marked off and sawn separately, templates being made for each course, but, when the work is parallel, and a large number of similar segments have to be sawn, three or four boards should be placed one on top of the other and the top board marked off with a template, after which, sprigs—the kind known as panel pins are suitable for thin segments—can be driven in as shown in Fig. 9. One cut of the band saw by this method gives three or four segments.

Large elbows or breeches pipes are common in some shops and they are invariably made by the skeleton method, even when a number of castings

are required, because they cannot be lagged up like a straight pipe, and they are too large to be made from solid timber. Skeleton patterns are satisfactory for one-off jobs, but if several castings are wanted, and a solid pattern can be made almost as quickly, it is certainly more profitable to make one. A very strong and comparatively cheap pattern can be made for an elbow or breeches pipe by the segmental method, with a little care. Figs. 10, 11, and 12, illustrate the construction of such patterns. Several grounds about 2 in. thick are first made, but an end view of the construction should be set out on the drawing board. The segments should not exceed about 1 in. thick and the grounds should be cut so that at no part will the pattern be less than 1¾ in. thick. The grounds have to be placed very accurately on the building or drawing board. The segments should be made so that it will be unnecessary to use a template, as template working is very slow and not more accurate. When such a pattern has been built, it can be finished with gouge and spokeshave very quickly. It will be observed that with the breeches pipe shown at Fig. 12 the construction is similar, although it is more difficult to mark off the segments. Instead of building on grounds when making elbows and other large bends by the segmental method, joint plates may be used, but it is not good practice, as it is practically certain that more trimming will be necessary with gouges and spokeshave.

The method we have been considering consists of a number of super-imposed layers with the joints alternating, similar indeed to the building of bricks. An alternative method which has the advantage of being prepared very quickly, is shown at Fig. 13. In this instance four segments only are used, and sawn larger than the required size to allow for finishing when the job is built, and the ends cut to form a series of tongues, as shown at Fig. 13. When all the ends have been cut—on the circular saw—glue can be applied to the tongues, and the segments interlocked and clamped up. It is an advantage to leave projecting pieces on the segments for this purpose. No nails or screws are needed with this method, and very little time is lost in waiting for the glue to set before cutting the work to the desired shape. This method is fairly satisfactory for rough work that is wanted quickly, but it should never be adopted for standard work or when there is time to build in laminæ of segments. Further, it is quite necessary that the pattern should be coated with paint or varnish.

Italian Iron and Steel Industry.

Capacity Figures.

In an interesting report on the present position of the Italian iron and steel industry the American Commercial Attaché at Rome (Mr. H. C. MacLean) gives figures indicating the existing capacity of the plants, and touches upon the conditions affecting Italian trade with foreign countries, mainly, of course, from the American viewpoint. We reproduce the following abstracts:

The Ilva iron and steel combination owns or controls three plants for making pig-iron, one at Bagnoli (on the Bay of Naples) with three blast furnaces; another at Portoferraio (on the island of Elba) with two; and the third at Piombino (on the mainland opposite Elba) with two. All these furnaces use coke. In addition, there are 8 small furnace plants using charcoal for special grades of iron and 14 plants producing "synthetic" iron from scrap.

Government reports enumerate 54 steel furnace plants in Italy. Their approximate full capacity is stated to amount to 1,500,000 metric tons, although the recorded maximum yearly output, attained in 1917, was only 1,331,641 metric tons. Less than 40 of these furnaces are now in operation. Provisional figures for 1921 give the total production of steel ingots and castings during the year as 683,200 tons.

In a normal year, like 1913, Italy's annual requirements might be broadly stated as 600,000 metric tons of pig-iron and 1,200,000 tons of semi-finished steel. The utmost productive capacity of Italian blast furnaces using coke can scarcely exceed 400,000 tons annually, and the furnaces supposedly good for this output are placed so as to furnish hot metal for steel production in adjoining departments of the plants to which they severally belong. For a year assumed to be normal, this would leave 200,000 tons of pig-iron, mostly of foundry grade, to be imported. [As a matter of fact, the actual output in 1921 was less than 76,000 tons of pig-iron of every kind including ferro alloys.]

Italian steel furnaces, if worked to capacity, should furnish 1,500,000, tons, as stated above, which would easily meet the requirements of a normal year. But since Italy has few merchant-steel furnaces, the latter, in general, being designed to prepare the metal for further working in the same establishments, under settled conditions imports of 200,000 to 250,000 tons of steel in the form of blooms, slabs, etc., would be needed yearly.

Canadian Notes.

According to announcements issued at Victoria, B.C., Mr. M. I. Landahl (Vancouver), one of the promoters of the Coast Range Steel Company, Limited, which plans the erection of an iron and steel smelting plant on the British Columbia Coast, states that a conference is to take place in London shortly between the officials of the Imperial Trades Facilities Committee, the Dominion Government, the Government of British Columbia, and representatives of the manufacturing interests associated with the project. The Hon. W. S. Fielding (Canadian Minister of Finance)—now at Geneva—is mentioned as the Dominion delegate; British Columbia being represented by either Hon. W. M. Sloan (Minister of Mines of the Province), or by Hon. John Hart (Provincial Minister of Finance).

An extensive body of iron ore is reported to have been discovered thirty miles north-west of Hudson Hope, Peace River, British Columbia. Samples of the ore assayed 60 per cent. iron, and proved to be self-fluxing. In contiguous territory there are large deposits of high-grade coking coal.

Prices of all kinds of iron and steel products are now advancing in Canada as the result of wage rate increases and the general upward trend in all factors having to do with production. Imports from British mills are increasing, and practically all the galvanised sheets and much of the blue annealed are coming from Great Britain. Some Scottish pig-iron is available in the Montreal market.

The Dominion Sheet Metal Corporation, Limited, of Hamilton, Ontario, are engaged on the enlargement by 50 per cent. of the producing capacity of their plant.

There has just been incorporated at Hamilton, Ontario, the Canadian By-Products Company, Limited, with an authorised capital of $600,000, for the purpose of manufacturing firebrick, fireproof building brick and tile. They purpose erecting a modern brick plant with a daily capacity of 20,000 firebricks and miscellaneous refractories. The Company state that the manufacture of firebrick is an industry hitherto unknown in Canada, owing to the absence of known deposits of fireclay capable of being commercially exploited. They hope to supply the demand for firebricks which has hitherto been met by imports from the United States and Scotland.

A Reference.

Mr. S. G. Smith informs us that he has had several enquiries as to the issues of the Foundry Trade Journal in which his articles appeared. The one entitled Making Flanged Cylinders Without Breaking up the Brickwork appeared in February and December, 1912, the latter issue also contained his article on Cupola Practice.

Automatic & Electric Furnaces, Limited, 281-283, Gray's Inn Road, London, W.C.1, have removed to larger works and offices at the Elecfurn Works, 173-175, Farringdon Road, London, E.C.1. In order to facilitate output, the new works are equipped with improved machine tools and labour-saving devices, and demonstration rooms, with furnaces in operation, will be provided, while laboratory and industrial electric muffles will also be available for trial purposes.

An Investigation on the Factors Influencing the Grain and Bond in Moulding Sands.*

By C. W. H. Holmes, B.Met. (Birtley, Durham).

(*Continued from page* 246.)

Origin and Nature of the Sands Used.

The Mansfield sand used was the variety known as "best moulding," and was obtained from the pits unmilled. Consecutive consignments of this sand have shown great regularity in grain, size, and bonds. It is typical of the best Bunter moulding sands, combining good venting properties with a fine grain and an excellent bond; also it is more refractory than many of the Bunter sands, being less micaceous. In addition, it possesses that "silky" texture which gains the confidence of the moulder, a matter of prime importance.

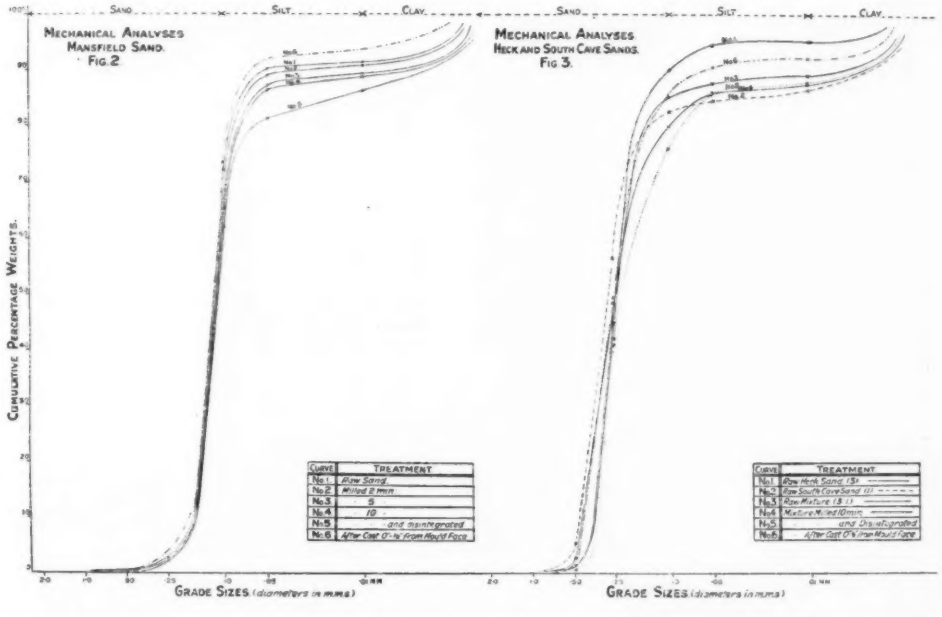
The Heck sand also occurs in the lower Bunter formation, but is more comparable to the Worksop deposit or to the coarser beds overlying the Mansfield "moulding sand." It is reddish-orange in colour and contains a fair amount of Muscovite.

The South Cave sand was the variety known as "South Cave Red." It is dark brown in colour and has, especially when its mechanical analysis is considered, a most remarkable bond. The peculiar stickiness of this sand is quite unique in the author's experience of English moulding sands. It is apt to be nodular and is not easy to sample accurately. Its chemical composition is sufficiently good to permit of its use as a bonding material in steel moulding. The mixture of Heck and of this sand is used, mixed with an equal amount of old sand, as a facing sand for green-sand work with great success. It occurs in the Jurassic System (Kelloway Beds).

The silica sand is a second-grade sand of unknown origin and is normally used solely in the making of "oil sand" cores.

The refractory clay used in the "silica sand and clay" mixture was obtained from the Yorkshire Amalgamated Products Limited's sand pits between Castle Howard and Huttons Ambo. These beds lie in the Lower Oolites, and the clay is found overlying well-defined beds of high-silica and kaolin-bearing silica sands of considerable purity and of widely differing mechanical characteristics. It would be more correctly classed as a strong loam than as clay. As will be seen from the bond adsorption figure, the clay grade is very "fat"; much more so than the kaolin bonding the sands beneath it. Unfortunately only sufficient was available for one test, which was made by adding the clay, ground dry, to the sand in the mill and tempering during milling. Had more been available, a second trial would have been made, adding the clay as a slip, which would probably have been more successful. In any case, the coating of smooth grains of silica with clay by mechanical means is a difficult and unsatisfactory proposition.

The Durham sand is of glacial origin. Both as considerable deposits and in isolated pockets, these sands are widely distributed in County Durham. The author has examined many samples varying from coarse bondless sands to silty loams containing up to 20 per cent. of clay grade. Whilst they appear to be quite useful from the bulk analysis, they are almost usually badly sorted as regards mechanical grading and consequently vent poorly. The bond is composed of a rather lean clay which burns out quickly, and the sand has a strong tendency to burn on to the casting. These glacial sands are widely used in the Tyne-Tees area, and their continual deficiency of bond is made good by additions of Erith or similar loam. The author believes, as regards the above district, that more defective castings are attributable to this practice than to any other single factor.



Consideration of the Result Obtained.

Amongst the new data presented in this report there is much that is difficult to interpret; there are also points upon which it is unwise to be dogmatic in view of the lack of data upon moulding sands in general. Some, however, of the results obtained afford new and quantitative data which should be of service to the ironfounder.

Examination of the mechanical analyses show a considerable and progressive degradation of grain size during the preparation of the sand. This degradation becomes more considerable when it is borne in mind that in practice the sand is milled several times during its useful life, and that the increase in grain size, which, contrary to expectation, was observed in each case after casting, must be apparent only, and due to causes which will be discussed later.

The Mansfield series (Fig. 2) is the most complete, and, as each curve is the mean of at least two elutriations, it is probably the most accurate. It is also the most easily interpreted. This sand, being fine grained, has a large surface over which

* Extracted from a Paper presented to the Iron and Steel Institute.

the bonding matter must be spread, hence it is fair to assume that this coating is thin enough to be affected almost throughout its depth before milling by the process of deflocculation, even though it may not be entirely removed from the enclosed sand grain. This contention is strongly supported by the comparatively slight increase in the bond adsorption value on milling the sand. Considerable light is thrown upon the high mechanical strength of the sand, and on the increase of strength on mechanical treatment by examination under a good hand lens × 7, and a low-power microscope × 35.

In the raw state the sand is seen to contain many clusters of grains which hold more than the average quantity of bonding material—and apparently the bulk of the fine silt as well—leaving less than the average amount for distribution over other grains; the points of contact between these latter grains being the weak link in the chain. Even after an hour's deflocculation and two hours in the elutriator, the grains retain their red tint due to a very thin pellicle of ferric oxide, which, in view of its resistance to solution in hydrochloric acid, would appear to be dehydrated and incapable of adsorbing dye.

The bond then would seem to exist in two forms:—(1) The mobile or hydrated bond which is capable of transference from grain to grain, and (2) the static bond which is fixed to the surface of the sand grains, forming a hold upon which the mobile bond may be evenly spread and displayed to the best advantage for mechanical strength. This static bond, common to all Bunter moulding sands that the writer has examined, although small in amount, certainly has a greater tendency to strengthen the sand than would a similar amount of mobile bonding material coupled with smooth grains of silica.

Alongside the grain degradation there occurs a consistent increase in the amount of clay grade separated; it is the most striking series of increases of all the grades, and is sufficiently large to be readily detected by the elutriator without the refinements adopted in this investigation. Bearing in mind that only a slight increase occurs in the bond adsorption value, it follows that practically the whole of the mobile bonding material must have been acted upon in the raw sand; consequently it would be expected to be removed in deflocculation without having to be rubbed off by the edge runner and disintegrator.

On the other hand this increase in the clay grade may have been produced by the mechanical reduction of sand to silt, and of silt to clay grade. The lower value of 1 per cent. clay grade in the prepared sand is evidence which strongly supports this latter theory.

It seems very probable that both factors have contributed an indeterminate share and also that the considerable attrition has removed a portion of the static bond, which, being of little use as mobile bond and having a low bond value, would naturally lower the value per unit of clay grade after preparation. The apparent increase in coarseness after casting is seen, on visual examination, to be due to the fritting of silt and clay around the sand grains and enlarging them. The loss of clay grade is a natural sequence of this. These aggregates are not broken down (although possibly to a small extent) by deflocculation; but treatment with hot hydrochloric acid causes separation in all but extreme cases taken from the mould faces.

The acid-cleaned silica grains from the face of the mould were opaque after casting, apparently due to internal cracking; and the bond on the uncleaned sand was bleached to a light grey, fading off through half an inch of pinkish sand to the original colour. This bleaching seems to be more of a physical than a chemical (reduction of ferric oxide) change, as the yellow ferric ions were noticeable at once on pouring acid on the sand in a test-tube. On re-milling the used sand, a fur-

Table I.—*Grade Chemical Analyses—Mansfield Sand.*

Grade.	Fine Sand.	Coarse Silt.	Clay Grade.
SiO_2	85.96	74.74	37.26
Fe_2O_3	1.24	0.94	3.44
Al_2O_3	6.26	7.28	18.32
CaO	1.54	4.23	15.58
MgO	0.90	2.47	2.10
K_2O	1.14	2.42	2.85
Na_2O	0.12	0.18	0.15
Loss on ignition	3.04	7.40	20.70
Total	100.20	99.66	100.40

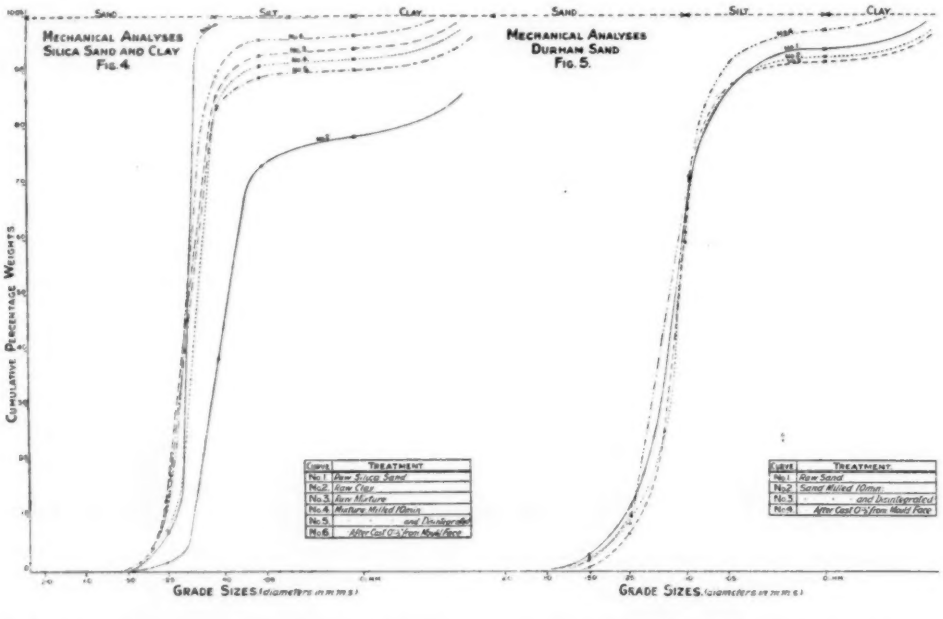


Table II.—*Grade Chemical Analyses—Heck and South Cave Sands.*

Grade	Raw S. Cave. Bulk Analysis.	Raw Heck. Bulk Analysis.	Mixture Medium Sand.	Mixture Fine Sand.	Mixture Clay Grade.
SiO_2	85.68 *	87.20	92.38	89.48	28.42
Fe_2O_3	5.68	1.75	0.56	1.60	9.80
Al_2O	4.30	5.23	3.36	4.58	13.78
CaO	0.24	0.20	trace	0.66	17.20
MgO	0.26	0.28	0.20	0.34	1.41
K_2O	0.48	3.04	1.85	1.72	4.62
Na_2O	0.18		0.21	0.28	0.24
TiO_2	0.15	N.D.	N.D.	N.D.	N.D.
Loss on ignition ..	2.48	1.45	1.08	1.30	24.00
Total ..	99.45	99.15	99.64	99.97	99.47

* Professor Boswell, "Memoir on Refractory Sands," Part I. gives 0.36 per cent. P_2O^5 due to glauconite in this sand.

ther portion of the fine silt and clay grades will be removed from the silica grains, and these, together with silt grade produced by the breaking down of the cracked grains referred to above, will gradually accumulate and yield a high content of

TABLE III.—*Grade Analyses—Silica Sand and Refractory Clay.**

Grades.	Bulk Analysis, Silica Sand. Analysis.	Clay.			
		Fine Sand.	Coarse Silt.	Fine Silt.	Clay Grade.
SiO_2	88.30	91.12	32.50	68.58	45.48
Fe_2O_3 ..	1.74	0.22	0.62	1.74	1.24
CaO	2.66	0.16	6.52	1.84	8.86
Al_2O_3	1.48	5.44	9.44	15.78	22.32
MgO	0.96	0.11	0.36	0.71	1.35
K_2O	0.42	1.06	1.54	2.16	3.08
Na_2O	0.35	0.31	0.47	0.38	0.44
TiO_2 † ..	N.D.	N.D.	N.D.	N.D.	N.D.
Loss on ignition ..	4.64	1.32	2.68	6.90	15.40
Total ..	100.20	99.74	98.13	97.99	98.17

* The grade analyses refer to the clay only and not to the mixture of sand and clay.
† Owing to lack of time the titanium was not determined. Professor Boswell, "Memoir on Refractory Sands," p. 136, gives 1.85 per cent. TiO_2 in a bulk analysis of this seam of clay.

silt grade, such as is almost invariably found in floor sands which have seen much service.

There is a double disadvantage involved in the use of sand of high fine high silt content: firstly, the porosity of the sand is seriously impaired, and secondly, the large surface displayed calls for a high clay content to cover it efficiently. The mixture of Heck and South Cave sands is the result of a successful attempt to imitate the good qualities of Mansfield sand in a coarser grain. In making up this mixture, South Cave sand was selected as having those properties which the writer has found to be essential in bonding materials for iron moulding sands in an unique degree, namely:—(*a*) A high content of fairly pure sand grade of considerable uniformity of grain size and possessing static bond. (*b*) A low content of silt grade. (*c*) A fairly high content of clay grade, exceedingly "fat," as shown by the dye adsorption value, of considerable permanence, as shown by the figures obtained from the "after cast" samples, and having a better chemical grade analysis than is really needed for this class of work (*vide* Mansfield clay grade). (*d*) A high content of ferric oxide, which in the writer's opinion has a very great influence upon the skin of the castings produced.

TABLE IV.—*Loss on Ignition per Cent.*

Sand.	Before Casting.	Distance from Mould Face after Casting.			
		0-½ Inch	1 Inch.	2 Inches	4 Inches
Mansfield	4.82	3.25	4.78	4.83	4.58
Heck and South Cave	2.40	1.55	2.15	2.30	2.36
Sand and clay ..	4.52	3.14	4.31	4.40	4 63
Durham	2.15	1.25	1.95	2.16	2.16

TABLE V.—*Values Shown per 1 per Cent. Clay Grade Separated in Elutriator.*

Sand	Mansfield.			Heck and South Cave.			Sand and Clay			Durham.		
Treatment	Raw.	Prepared	Cast.	Raw.	Prepared	Cast.	Raw.	Prepared	Cast.	Raw.	Prepared	Cast.
Clay Grade	8.33	15.40	6.20	6.20	12.10	7.70	5.90	9.70	3.50	6.05	8.20	2.85
Transverse strength per 1 per cent. clay	11.20	11.05	19.40	15.10	34.50	10.10	—	6.50	—	6.30	6.71	5.60
Compressive strength per 1 per cent. clay	69.5	56.8	75.5	34.4	106.0	45.7	—	20.10	37.0	26.5	23.2	42.1
Bond adsorption per 1 per cent. clay ..	139.0	80.5	110.0	112.0	149.0	88.0	119.0	72.0	68.5	52.5	41.4	38.6
Loss on ignition per 1 per cent. clay ..	0.575	0.314	0.525	0.220	0.198	0.202	0.765	0.465	0.895	0.355	0.262	0.438

TABLE VI.—*Grade Analysis—Durham Sand.*

Grade.	Sand.	Silt.	Clay Grade.
SiO_2	94.20	80.35	50.20
Fe_2O_3	1.24	3.18	5.34
Al_2O_3	3.05	8.56	21.54
CaO	0.15	0.60	2 26
MgO	0.20	1.24	5.12
Alkalies	1.04	1.95	4.77
Loss on ignition	0.40	4.35	10.84
Total	99.88	100.23	100.06

This point is now under investigation in the Laboratory of the Birtley Iron Company.

Worksop sand was too fine in grain size, otherwise it would have been quite suitable. In Heck sand all the requirements are fulfilled.

Examination of the results shows that a large increase both in bond value and in mechanical strength occurs on milling and disintegration. When it is considered that the bulk of the bond is distributed, in a rather nodular state, over one-quarter of the sand, and that this has to be distributed over the remaining three-quarters, this increase is not surprising. The bond distribution factors, *id est*, strength of transverse bar multiplied by 100 and divided by the bond adsorption value, tend to show, however, that the limit of useful milling has been reached at the end of 10 minutes.

The dye adsorption values show an increase which is much more considerable than had been expected; evidently deflocculation is not violent enough to reduce the strong clay nodules to a fine state of division.

Unit clay grade shows a higher value after milling, in comparison with that before, than in any of the other sands, and this lends support to the suggestion that useful mobile bond is progressively displayed as milling proceeds, to such an extent as to overcome the diluting effect of detrital matter resulting from degradation of sand and silt. The permanence of the bond is satisfactory, though not so good as in the Mansfield sand; it would seem to be affected by temperatures below 200 deg. C. to a greater extent than the Mansfield bond, and this may be due to the South Cave bond being less ferruginous and more argillaceous than the bond in the Mansfield sand.

The values obtained in the tests on the silica sand and clay mixture are not of very great value; the clay was added dry and in size smaller than 10-mesh, tempering being effected during milling; pellets of clay were present even in the disintegrated sand, giving poorer tests than should have been obtained, and rendering accurate sampling impossible.

The fact that the raw mixture was too weak to give any mechanical tests also detracts from the value of the series. The detrimental effect upon bond distribution of the lack of static bond on the smooth grains of silica is accentuated by the modified success of the series of tests. The difficulty of coating smooth silica grains with clay is, however, well known; it is remarked upon by Dr. Moldenke in his "Principles of Ironfounding," and also in a paper read before the Institution of British Foundrymen, 1919-20.

Hanley* describes the successful mixing of new well-bonded sand, old sand, and a proportion of a poorly bonded local sand, together with a small quantity of fat refractory clay. The author has

* Proceedings of the American Foundrymen's Association 1920.

also succeeded in doing this, but only in such proportions that the grains with static bond predominate.

Finally, the Durham sand is an instance of great interest, almost the opposite of the Mansfield and Heck and South Cave sands. It is a sand which, on bulk chemical analysis, appears to be an excellent one, yet this promise is not borne out in practice. The author has used a considerable quantity of a Durham glacial sand of rather better composition than the sample here investigated; it vented badly, produced an indifferent skin on the castings, and lost its bond rapidly. The facts here demonstrated go far to explain this apparent contradiction between theory and practice; on examining the bond adsorption values it is evident that the sand is bonded with a rather lean clay which is not nearly so permanent as is that of the Bunter sands.

As regards the appearance of the castings produced from the test moulds, which were not blacked nor protected in any way, the casting from the Mansfield test had an excellent smooth blue skin which was only slightly better than that obtained with the Heck and South Cave mixture. The standard clay mixture came out with a loose scale of sand and minute pellets of burnt clay, which was rather reminiscent of a steel casting from a "compo" mould.

The Durham sand gave a greyish blue skin, rather rough owing to burning on.

Whilst the refractoriness of these sands is not one of the subjects under investigation, the writer feels that it is not out of place to suggest that the ferric oxide content of moulding sands for grey-iron founding will one day, when the matter is fully investigated, be classed as a factor of prime importance. Although no evidence can be brought at the moment to support such a theory, it may be that in the presence of ferric oxide a smooth blue skin of Fe_3O_4 is formed in preference to one of high FeO content, and consequently having a smaller tendency to form ferrous silicates with the sand grains. The curve showing the maximum temperatures to which the sands were subjected is a mean curve from the four casts, the results from which were practically identical. It will be noticed that the mean point for the aluminium wire lies outside the smooth curve; this is due to its higher thermal conductivity. In the absence of a pyrometer, casting temperatures could not be determined, but would be in all cases approximately 1,250 deg. C.

Conclusions.

1. That the mechanical and physical properties of sands for grey-iron founding are of equal importance to the chemical analysis.

2. That the bond adsorption value obtained on the raw sand may be greatly modified by mechanical treatment.

3. That the most successful moulding sands contain both static and mobile bond.

4. That an appreciable degradation of the grains of a moulding sand occurs during the mechanical preparation as usually effected.

5. That the bond distribution factor is a characteristic of moulding sands that is of great importance in view of the excessive degradation which may be caused by prolonging milling beyond the time needed to effect the optimum distribution.

6. That no single test is sufficient on which to judge the practical value of many moulding sands, but a careful consideration of all those tests which have been described above.

The writer wishes to thank Mr. K. C. Appleyard, General Manager of The Birtley Iron Company, for having readily granted every possible facility for the conduct of this research. Also Mr. J. Brewis, Works Manager, for his ready assistance in many details.

Boron as a Steel Alloy.—Experimental work performed by the U.S. Bureau of Mines indicates that the use of boron as an alloy confers marked hardness on steel. If the other physical properties of the boron steels are good enough to be applicable to commercial use their remarkable plasticity at temperatures below the melting points of ordinary steels might make it possible to utilise this characteristic.

The Institute of Metals.

Discussion on White Metals.*

Sir Henry Fowler, K.B.E., in opening the discussion, said that some time ago, at the instigation of Mr. Weeks, he looked very carefully into the question of various white-metal alloys used for locomotive purposes. He was under the impression that the alloy which was very largely used in the aeronautical work was not that given in paragraph No. 1, but that it approximated more closely that given in paragraph No. 2, namely, 85 per cent. tin, 10 per cent. antimony, and 5 per cent. copper, with the Brinell hardness as stated in the Paper. That was a metal which had been very highly spoken of by a French observer as being one of the best metals in existence. One point in locomotive work and motor car work which was of very great importance had been accentuated in the Paper, namely, the question of whether a metal was being used which was simply a bearing metal, or one which was resistant to alternating pressure. It was necessary in all reciprocating engines to have a metal which would not spread when it received a blow, and the metal with the composition of 85:10:5 was used almost universally for locomotive purposes, and for other engine purposes where repetition stresses occurred. The great difficulty existed in locomotive and motor-car work of getting a considerable pressure. Although some of his colleagues on other railways used a metal which approximated very closely to that given in paragraph No. 5, namely, tin 60, antimony 10, copper 2, and lead 28, a close investigation had not led to some of the other railways, which would like to use that type of metal, adopting it, owing to the fact that they were not able to get quite as low a pressure owing to the gauge and other reasons as those who used it satisfactorily. A third metal was used very extensively on railways, but no reference was made to it in the Paper. It approximated to alloy No. 7—tin 12, antimony 13, lead 75—and it had a Brinell hardness considerably lower than the figure stated. If there were any changes of stress that was a very satisfactory metal to use; indeed, it was very extensively used at the present moment. The author referred to the use of a metal similar to No. 9 on Continental railways, particularly in Central Europe, but he was surprised to find that the Brinell hardness of that metal was about 25. He had the opportunity since the war of seeing certain of the metals in use on the Continental railways, and personally he would have said that the Brinell hardness figure was lower than that stated in the Paper. He desired, in conclusion, to refer to the question of the eutectic providing a space in which oil lie. He knew, from experience obtained fifteen or eighteen years ago, that trouble was caused in certain cases. Owing to the conditions under which the metal containing 85 per cent. tin was cast, cuboid crystals stood high, the eutectic melted away, and great trouble was caused with hot bearings. That was entirely due to the temperature. He desired to emphasise the point that had been made, not only at the present but at other meetings of the Institution, that the one thing it was necessary to deal with from the works standpoint was the question of temperature control. It was necessary constantly to press home that point upon those responsible, because it applied not only to white metals, but to other metals as well. When pouring out of a ladle difficulty occurred in obtaining that temperature control which meant so much in obtaining a satisfactory white-metal bearing.

The Author's Reply.

Mr. A. H. Mundey, in reply, said the author quite expected to be taken to task at the attempt at theorisation they had made with regard to the cause of the distribution of the oil film due to the irregularity of the structure. Sir Henry Fowler had expressed surprise that the authors should have stated that No. 1 was the bearing metal which was commonly used in aero-engines. Perhaps the authors had over-stressed the point by saying that No. 1 metal was chiefly used, but certainly that metal was largely used on certain engines which gave a vast amount of trouble, and that point was very much impressed upon them. Personally, he was responsible for giving the matter undue prominence.

* This Paper appeared in our last issue

Turbine Steam Chest Troubles.

By S. G. Smith.

The castings entering into this category are numerous, and include turbine-engine parts, condensers, coolers, gas and oil engines, also air and vacuum castings.

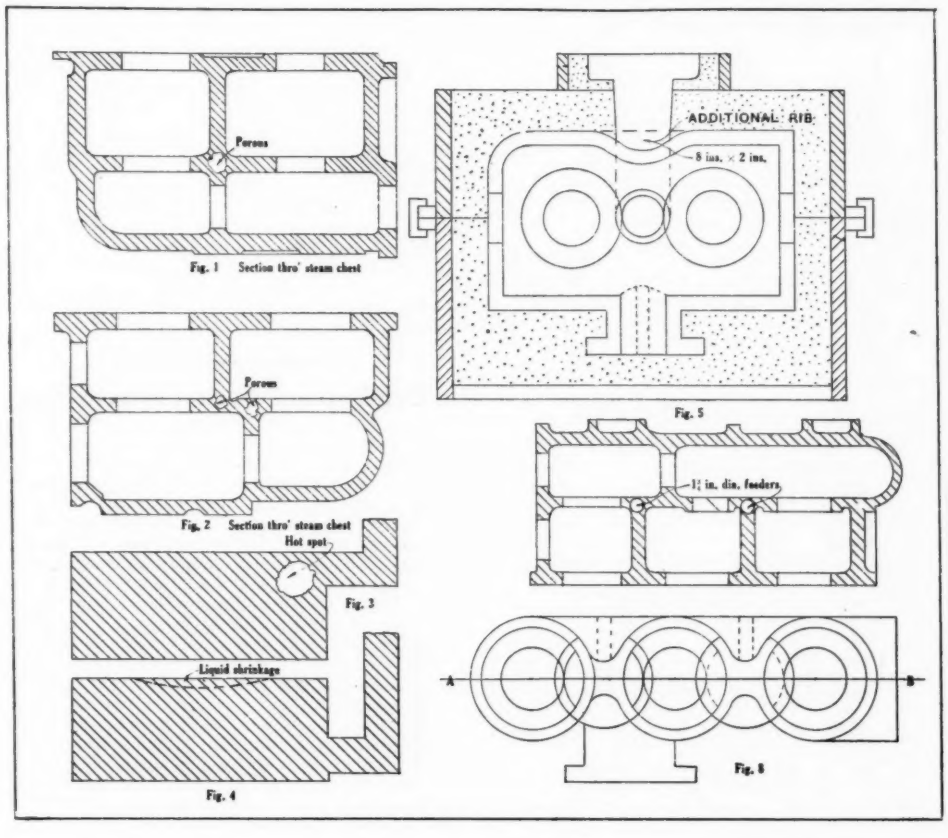
Steam Chest for Rateau-Impulse Turbine.

Steam chests for turbines are made in both iron and steel, and vary in weight from 10 to 50 cwts. The water test applied ranges between 250 and 500lbs. per sq. in. Steel shows one advantage, being weldable, whereas cast iron does not readily lend itself to this treatment, despite what has been said to the contrary. Very often a bad steel steam chest can be made good by welding, whereas a very slight defect in an iron casting will scrap it. Although a steel steam chest can be welded, large numbers are so porous that even welding fails to make them water-tight.

chests were suggested, but this presented too many engineering difficulties, hence no other course was open but to persevere in the foundry.

One of the worst features about these castings was that all machinery, boring, drilling, and threading were completed before the testing could be carried out, which would mean that all labour and time spent upon these operations were lost if the casting failed; this often happened, and was a very serious loss of time and labour. The porous places were chiefly found at the junctions of the internal partition walls. When this occurred it did not admit of being easily cured, consequently the casting was usually scrapped.

Figs. 1 and 2 give the location of the porous places. It was quite natural for these to exist just where they are, seeing that the liquid iron at the junctions of the internal partitions was completely



Defects.

The defects in both steel and iron steam chests are often situated in the same places. This is not surprising, as the trouble in either case arises from liquid shrinkage, which shows up during the pressure test.

As a rule, when properly moulded, and poured with a good-quality iron at a fairly high temperature, the large steam chests give the least trouble, and a waster in the foundry or machine shop is rare. It is the small, chubby, heavy section steam chest that gives most trouble under water pressure test, and it is to these particular chests that these remarks refer.

These chubby steam chests, which each weigh from 10 to 15 cwt. when cast, have four partitions, or part-partitions when moulded. Four separate water-test pressures are applied, one in each of three chambers and one for the whole of the outside section; this means that not an inch of internal or external surface escapes water pressure, and in each case under observation.

Alteration in the design of these particular enclosed within a circle of liquid metal, comprising the outside walls, thus the thick sections of the internal partition walls would be much longer in the liquid state than the surrounding walls, hence the inevitable drawing away from the parts that were longest in the liquid state, in other words, the parts that were last to solidify.

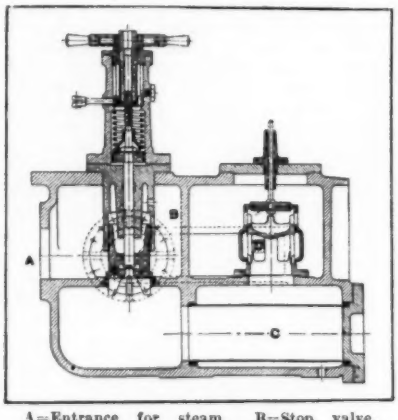
The problem was how to obtain the soundness required at these junctions under such circumstances.

There are several conditions which contribute to porous and open places in an iron casting, amongst which are the following:—The hottest spot or area in a casting is a place liable to be porous. It does not always follow that this is the thickest section of a casting, although in many cases this is so. It is an accepted rule that the heavy places require feeding. To illustrate this take a small plain casting of equal dimensions; if the ingate is at the top in all probability the drawn place will be quite near to it, as shown in Fig. 3. Now if the ingate was situated at the bottom, as in Fig. 4, the hot spot or area would be rendered

sound by static pressure. If one could always control the porous places by altering the position of the ingate runner they would soon disappear. Unfortunately this cannot be done. Another place where porosity is apt to occur is at thick and thin places when in close proximity. Also there is a possibility of porosity existing due to the phosphorus eutectic; each of these aspects will be discussed as certain castings are being dealt with.

Steam Chest.

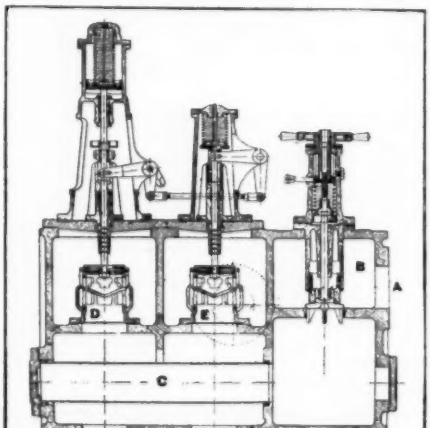
Reverting back to the steam chest, in order that the external shape of the pattern should not be



A=Entrance for steam. B=Stop valve. C=Strainer. D=Governor valve.

Fig. 6.—Section through Steam Chest for Small Turbine, Sketched in Fig. 1.

altered, the writer resorted to several devices for its prevention. Chills, for instance, were applied at various places on the outside of the pattern, and also were placed in the core boxes and rammed into the cores at the junctions of the internal walls. They were also made in various shapes and cast into the section of the metal at the junctions. In fact, denseners were applied, many and few, both inside and outside. Although the moulds were almost plastered with them, leakages still



A=Connection for steam pipe. B=Stop valve. C=Strainer. D=Main governor valve. E=Automatic overload valve.

Fig. 7.—Section through Steam Chest for Medium Turbine.

occurred under water test. Feeders as large as practical to the contour of the pattern were tried but to no avail. The castings were poured at high, medium, and low temperatures with the same result. Also the mixture and analysis of the iron was varied, but with little or no improvement. The static pressure put on the mould when pouring by increased height of the runners and feeders was almost enough to burst the moulding box; these and other methods were tried, but a satisfactory permanent result was not obtained. As a last resource, and without any internal alteration design and no material alteration externally, a thick rib was added to the pattern immediately opposite and above the internal junctions which were porous. The distance between the additional rib and the porous places would be about 10 in. This rib, the thickness of which was 2½ in. and the length about 8 in., completely covered the internal junctions. Above this a specially large feeding riser was fixed, the thickness and length of which would be a little less than the rib. A large feeding head or reservoir was provided above the feeder. The dimensions of the feeding rib, riser, and head were such that two ½-in. round feeding rods could be worked at the same time which passed right through the chamber walls and junctions, a depth of 24 in. from the feeding head. With the addition of hot feeding iron both feeding rods were working for twenty minutes; thus the feeding mass kept alive and liquid as long as the internal area that enclosed the porous junctions.

This method, when properly and intelligently carried out, effected a cure every time, and the records showed that 18 succeeding castings were perfectly sound and exhibited no sign of defect when under water test. The length of time that the interior remained in the liquid state was a revelation.

The design of the pattern being unaltered neither internally nor externally, the additional rib for feeding purposes could be drilled and taken off if necessary. The contour of the top half of the pattern as poured was only slightly altered.

The writer, during his career, has tackled many foundry problems, but no casting has given more anxiety than this design of steam chest. So long as this design of steam chest is made there will be trouble under the pressure test unless all precautions mentioned are strictly observed.

Fig. 7 emphasises the importance that the seatings of the valves, and the partitions of the compartments, should be absolutely proof against any leakage from one into the other; hence the four pressure tests are always applied.

Bricks from Blast-Furnace Slag.

Numerous devices and processes have been devised to dispose of blast-furnace slag. However, most methods are expensive and fail to produce the desired results. The idea presented in a recent issue of the American "Mining and Metallurgy" has been protected by recent patents. For utilisation of blast-furnace slag the following scheme is proposed:—

(1) Discharge slag directly from furnace into cars, which contain several feet of water.

(2) Place disintegrated slag in centrifugal drier.

(3) Run product through pulveriser, crushing slag so that 75 per cent. will pass through a 100-mesh sieve.

(4) Mix one part of cement with 12 parts of powdered slag, adding small amount of water.

(5) Mould the resulting mixture in bricks of standard size, in presses. Bricks made from blast-furnace slag have been tested at Lehigh University with the following results:—

Transverse Test.—Support ⅞ in. from each end. Width 2 5-16 in., depth 4 in. Span 7 in. Average breaking load, 7,000 lbs.

Compression Test.—Bricks were set on edge, after being broken in half. The following area was subjected to compression: Length 4 3-16 in., breadth 2 5-16 in. Average breaking load, 80,000 lbs., or ultimate strength of 8,500 lbs. per sq. in.

Absorption Test.—In a period of 11 days the bricks absorbed 7.15 per cent. of their weight in moisture.

Shearing Test.—When subjected to a double shearing test they failed at unit load of 1,650 lbs. per sq. in.

These tests show that bricks made from blast-furnace slag have a strength far above the average made from shale or clay. The texture of the bricks is uniform, and an even, smooth surface results from the described method of manufacture. The cost is far less than that of making bricks from clay or shale, as the whole process can be operated in conjunction with the blast furnaces of any iron and steel plant.

The Boom of the German Iron Market.

The Commercial Secretary at Cologne has forwarded the following extract from the "Frankfurter Zeitung" for September 12:—

The month of August saw the failure of the London negotiations and the consequent fall of the mark, with its many fluctuations, under which impression the demand for the products of the heavy industry remained extraordinarily brisk, trade and consumers endeavouring to cover their requirements before a further increase set in. The demand was therefore great, the only exception being thick plate, which was no doubt due to the lack of employment on the wharves. In bar iron, sections, middle and thin plate on the contrary everything available was bought. The extraordinary demand which is asserting itself is to be attributed to the separation of the Upper Silesian Works and the irregular working at the present time of that industry, and the consequence will certainly be that large quantities of bar iron will be imported from the Saar district, Luxemburg and Lorraine. This danger is all the greater as the difficulties of production have not improved. The works are suffering continually from an insufficient coke supply and a shortage of workers, so that great difficulty is experienced in keeping to terms of delivery.

The demand from abroad was in general satisfactory, especially in thin and middle plate. Prices, however, show a downward trend. Belgian competition was very much felt, as was also English competition, especially as England delivers more punctually. The tremendous new price increases were met with great hostility by the public. The Minister of Economics was of the opinion that the time had come to intervene with coercive measures in the iron industry. During the negotiations at the Eisenwirtschaftsbund the representatives of manufacturers, consumers and trade were, however, successful in persuading at least a part of the employees that the re-introduction of maximum prices would at the present time be the worst and, from an economic point of view, the most harmful measure possible. The re-introduction was rejected by 24 votes to 12. With the increased monetary requirements for purchases and other reasons, the inevitable want of working capital is likely to restrict greatly business activity even if it does not lead to unemployment. The same reasons will prevent the finishing or the new building of business premises and dwelling houses. Anxiety is growing in regard to the prospects of continuing to find employment for the many thousands of people employed in the iron industry. Foreign competition notes with satisfaction the German price increase. In these circumstances it is impossible to keep up export trade against foreign competition which—with the help of German coal—is disputing the market to Germany. But of far more importance is the fact that, in view of prices and the short terms of delivery, foreign competition is being felt in Germany itself. This is all the consequence of the great German coal shortage. The ore deliveries continued to suffer on account of the shippers' strike in Holland, which had not come to an end. Owing to the tremendous mark depreciation, the demand for inland ores was very brisk and could not be satisfied, especially as during the first part of the month the ore deliveries, particularly in Siegerland, suffered from a truck shortage. In foreign ores business was dull, the smelting works keeping aloof owing to the fall of the mark and the shortage of coke and money. No business transactions worth mentioning were concluded either in Swedish or Spanish ores. Vabana ores are being supplied regularly and satisfactorily. Contracts were made recently for the current year at the price of 18s. 3d. c.i.f. Rotterdam on the former basis. Further negotiations are pending in regard to new contracts in Vabana ores for delivery in 1923. New contracts in Lorraine minette were concluded with the Syndicate for delivery until the end of the year, but the quantities in question are far smaller than those for the third quarter. Prices are quoted 25 cts. more than last contracts, amounting to Fr. 11.75 c.i.f. Gr. Mövern, or Fr. 12.50 c.i.f. Algringen. Briey minette has been offered a great deal of late both by the Syndicate as well as by dealers at Fr. 14.50 c.i.f. Conflans, or Fr. 21.50 ex frontier on the basis 35 per cent. iron. On the manganese ore market offers were scarce and prices steady. Prices on the scrap market followed the foreign bill market. Heavy scrap increased to 15,000 Mks. Turnovers were, however, small, as consumers and dealers held aloof on account of the uncertainty of economic conditions.

The pig-iron market remained very strained. The inland demand could not be fully met in most kinds of pig-iron, so that the Pig-Iron Association saw itself forced, in spite of the unfavourable exchange, to import foreign supplies. The demand for semi-manufactures was very brisk, as, in view of the development of the exchange, supplies of foreign semi-manufactures were out of the question. Requirements were therefore not always met. A great shortage was to be observed in material for railway tracks, and the demand of the Railway Central Office, as well as that of private sources, could not be fully satisfied. Requirements in rails for mines and sleepers were only covered in part. The supplies of sections were unsatisfactory. The decline in employment in railway rolling stock observed last month showed no signs of improvement, the chief reason being that the State Railway administration is holding back with the distribution of orders. In bar iron and hoop iron the works are fully occupied, and the orders on hand guarantee employment for the next few months. Export business was dull, no large contracts being concluded. In thin plate inland trade was very brisk, but no exports took place. Thin and middle plate were very much in demand, but there were but few inquiries for thick plate. Cast-iron pipes were very much sought after, there being many inquiries from abroad. On the wire market the demand for wire rod was as great as last month.

Contracts Open.

Newton Abbot.—New or second-hand 6-in. and 9-in. cast-iron pipes, for the Newton Abbot Rural District Council. Mr. S. Olver, highway surveyor, 9, Marlborough Terrace, Bovey Tracey.

London, S.E., October 6.—Shovels, etc., for the High Commissioner for India, viz., 8,004 shovels, round nose, with handles; and 3,000 shovels, stoking, with handles; 2,500 cocks, bib, galvanised, ½ in. and ¾ in.; and 1,634 cocks, stop, galvanised, ¾ in. to 4½ in.; (3) 45,000 ft. point rodding, 1¼ in., solid, complete with bolts and nuts. The Director-General, India Store Department, Belvedere Road, Lambeth, S.E.1.

Deaths.

Mr. F. W. Ballard, ironfounder, of Abingdon, died recently at the age of 63.

Mr. W. Hexter, a director of the South-Western Brass Foundry, Limited, Plymouth, died recently at the age of 71.

Sir Richard Martin, a director of the Swansea Vale Spelter Company, Limited, died on September 16 at the age of 79. The deceased gentleman was born at Pentremawr, Swansea, in 1843, and was first employed at the Millbrook Iron Works. In 1867 he entered H.M. Customs at Swansea as a clerk, was transferred to Grimsby, but three years later he returned to Swansea and commenced in business on his own account. In 1879 he joined a few friends in the establishment of the Swansea Vale Spelter Works at Llansamlet (with which he maintained an association to the end), and in 1881 he established a steelworks at Birchgrove, and in 1884 the company of which he was managing director acquired the Ynispenllwch Tinplate Works. His association with industry continued to the end, but the only works he was in his later years actively connected with was the Swansea Vale Spelter Works.

J. Blakeborough & Sons, Limited, of Brighouse, Yorkshire, have amalgamated their business with that of George Kent, Limited, 199, High Holborn, London, W.C.1.

Trade Talk.

MR. R. HUTCHESON has removed to 2, Mair Street, Plantation, Glasgow.

BEECROFT & PARTNERS, LIMITED, have removed to St. Peter's Close, Sheffield.

MR. H. F. BARTON, metal trade valuer, has removed to 39, Albion Place, Sittingbourne Road, Maidstone.

THE IRONCLAD SWITCHGEAR COMPANY, LIMITED, have removed their London offices to 23, Queen Anne's Gate, Westminster, S.W.1.

SHAND, MASON & COMPANY, fire engine manufacturers, etc., are retiring from business, the goodwill of which is to be sold.

ALEXANDER STEPHENS & SONS, LIMITED, Linthouse, Govan, Glasgow, have secured a contract for a new steamer of 6,000 tons for Elders & Fyffes, Limited, Glasgow.

AS A RESULT of a decision that the furnaces at the Elba Steelworks, Gowerton, should not be lit last week 200 men employed in the melting shops are out of employment.

MR. H. P. ALLEN, late of Burton, Griffiths & Company, Limited, has taken over the representation of Bell's United Asbestos Company, Limited, in Leeds and North Lancashire.

ALFRED HERBERT, LIMITED, have taken over the agency of the Cleveland Automatic Machine Company, Cleveland, Ohio, U.S.A., for the Cleveland automatic screw and forming machines.

IN consequence of the Ebbw Vale Steel, Iron & Coal Company's works in Wales being stopped by a wages dispute, the five hundred employés at the firm's Irthlingborough (Northamptonshire) mines received a week's notice on Friday last.

PIECEWORK price rates were the cause of a dispute at the shipyard of Chas. Connell & Company, Limited, Scotstoun, as a result of which some frame squads are on strike. Only a small number of riveters are involved, but the strike has thrown a good many helpers out of work.

MESSRS. J. C. BISHOP and O. Coyle, joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board, announce the result of the audit for July and August. This certifies the average net selling price as £11 0s. 7.25d., with a decrease in the wages of the workmen of 2½ per cent., on basis rates.

LICENCES under the Non-Ferrous Metal Industry Act, 1918, have been granted to H. Bath & Son, Limited, 53, New Broad Street, London, E.C.2; R. B. Bethell & Company, Limited, 29, Exchange Chambers, Liverpool; E. M. Boundy, 15, New Street, Bishopsgate, London, E.C.2; and E. Eastwood, Dolphin Place, Ardwick Green, Higher Ardwick, Manchester.

WE REGRET that, in consequence of a printer's error, we stated in our last issue that the English Electric Company, Limited, were closing their works. The correct wording should have been "their Coventry works." We are informed by the company that this decision was arrived at owing to continued trade depression and the dearth of export orders, and that they propose to concentrate production in their four other works at Preston, Bradford, Stafford and Rugby.

IN CONNECTION with the South Wales and Monmouthshire iron and steelworkers' sliding-scale, the joint auditors' report for the three months ended August 31, 1922, shows that the average net selling price of steel rails (20 lb. per yard and upwards) and steel tin bars is lower than in the previous quarter to the extent of over 9s. per ton. The sliding scale will, therefore, fall 4½ per cent. as and from October 1—that is, from 55½ to 51 per cent. above standard, which will be the ruling percentage to December 31 of this year.

BELLISS & MORCOM, LIMITED, Ledsam Street Works, Birmingham, have sets of lantern slides, each consisting of twenty slides with a booklet of descriptive matter, which they will supply on loan free of charge for lecture purposes. These slides include quick-revolution engines with forced lubrication, and the production of power at low cost in conjunction with heating and drying by exhaust steam.

THE STAMPED OR PRESSED METAL WARES TRADE BOARD have sent notification to the Minister of Labour that, after considering all objections lodged with them, they have varied the minimum rates of wages for certain classes of skilled male workers, in accordance with the provisions of their notice dated June 21 last. The Minister is asked to confirm the rates as varied, and to bring them into operation on October 14. The new minimum rates are based on a sliding scale according to the cost of living index figure.

MR. M. R. LAWRENCE, works manager of the Sterling Telephone and Electric Company, Limited, Dagenham, Essex, has been re-elected as president of the Institution of Production Engineers for the 1922-1923 session. During February a paper on "Machine Moulding Methods" will be read by Mr. F. T. Hardyman, foundry manager to Petters, Limited, Yeovil. Local branches of the Institution have already been formed at Coventry and Newark-on-Trent, and it is hoped to inaugurate a local section at Glasgow during the coming session.

AN AGREEMENT was reached on Wednesday between the Negotiating Committee of the Railway Managers' and the Trade Unions with respect to the war wage of workmen employed in the railway shops. Under the terms of the agreement the war wage of 26s. 6d. per week will be reduced from October 2 by 10s. per week, and wages will be stabilised on this basis until December 31. The settlement, which has been effected by the parties, gives an advantage of 6s. 6d. per week to the craftsmen and unskilled workers in railway shops as compared with the men employed in general engineering establishments.

ON October 10 the representatives of the Engineering and Shipbuilding Trades' Federation are to meet the shipbuilders and announce the Federation's attitude towards the proposal made by the masters that the remaining 10s. of the 26s. 6d. war bonus shall be discontinued as from November 1. The employers propose that this shall apply to all but the lower paid men, and, conditional upon its acceptance, have expressed a willingness to agree to a period of stability during which there will be no further national general fluctuations. So far as the lower paid men are concerned, the absorption of the remaining war bonus shall be applied at intervals and to an extent justified by a scale the employers are willing to discuss with the labourers' Unions, but reductions below 37s. 6d. per week are not likely to be proposed from the masters' side. At the moment the Federation is taking a ballot of its members on the proposals.

Company News.

Furness, Withy & Company, Limited.—Half-yearly ordinary dividend, 5 per cent. per annum, free of tax.

Midland Electric Corporation for Power Distribution, Limited.—Interim ordinary dividend, 8 per cent. per annum, less tax.

Star Engineering Company, Limited.—Dividend on preference and ordinary passed; debit balance, £5,590, carried forward.

Jackson-Rigby Engineering Company, Limited.—Capital £3,000. Directors: A. G. B. Chaldecott, S. Jackson and H. Greenly.

Arthur G. Foulds, Limited, Dunedin Street, Edinburgh.—Engineers. Capital £20,000 in £1 shares. Directors: A. G. Foulds and E. E. Chalmers.

Ajax Production Engineers, Limited, 188-189, Strand, W.C.2.—Capital £3,000 in £1 shares (1,500 ordinary and 1,500 7 per cent. cumulative preferred. Secretary: H. J. Bellingham.

Partington Steel & Iron Company, Limited.—Net profit, £10,389; interest, £85,978; brought in, £34,717; dividends on preference shares, £21,000; ordinary dividend passed; carried forward, £24,106.

Galpin & Coulton, Limited, 43 and 49, Gunnersbury Lane, Acton.—Engineers. Capital £7,500, in 7,200 8 per cent. cumulative preferred ordinary of £1 and 6,000 deferred shares of 1s. Director: C. T. Galpin.

Watson Lister, Limited, Ashburton Road, Trafford Park, Manchester.—Engineers. Capital £10,000 in £1 shares (8,000 cumulative participating preferred and 2,000 ordinary). Directors: W. W. Lister, C. J. Hobson and A. J. Adams.

Mahler & Company, Limited, 705-709, Royal Liver Buildings, Liverpool.—Capital £20,000. Manufacturers, importers and exporters of and dealers in iron, steel, metals, minerals, etc. Directors: W. H. Jones, W. D. Peet, and A. A. Travers.

Dobson & Barlow, Limited.—Profit, £266,512; brought forward, £20,878; available, £287,390; final dividend on ordinary, 20 per cent. per annum, making 20 per cent. for year; bonus, 2s. per share, tax free; reserve, £135,000; carried forward, £67,890.

Thompson Engineering Company, Limited.—Capital £3,000 in £1 shares, to acquire the business carried on by J. Thompson at Haddrick's Mill Ridge, South Gosforth, Northumberland, as the Thompson's Engineering Company. Director: J. Thompson.

Thomas W. Ward, Limited.—Preparation of two years' balance-sheet postponed pending settlement re excess profits duty. Quarterly dividends, 5 per cent. per annum on first and second preference and employés' shares; dividend 10 per cent., free of tax, paid for year to June, 1921.

Dalmellington Iron Company, Limited.—Profit, £35,601; brought forward, £7,577; total, £42,978; depreciation, etc., £15,953; preference dividend, £6,500; interim ordinary dividend, £6,825; final dividend, 6d. per share, free of tax, making 5 per cent. for year; carry forward, £6,874.

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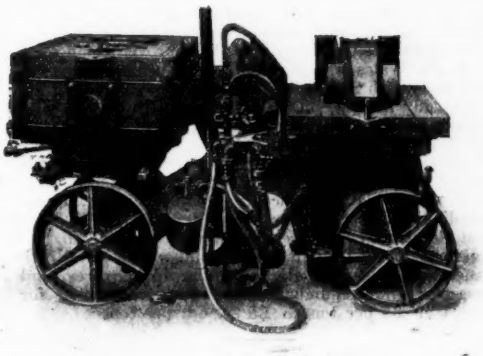

The Finished Mould—showing Pattern after being drawn.

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IRON AND STEEL MARKETS.

Pig-iron.

The opening of the final quarter of the year's trading gives, at present, faint promise of stable improvement in the pig-iron industry, which, although to some extent better than in the corresponding period of 1921, still leaves much to be desired in the volume of business transacted. This may be specially noted in the case of the South Staffordshire area, where the production of iron is still restricted to unimportant hand-to-mouth deliveries, barely sufficient to keep the limited number of furnaces now in blast in operation. Smelters in this district (as in others) are considerably handicapped by the continued high cost of production, which precludes the possibility of reducing prices, and in some instances furnaces are even said to be working at a loss. Consequently prices in the Midland market retain their firmness, with quotations, as given on another page, unaltered. The Glasgow pig-iron market has been a little quieter of late, the demand from America being easier—at least, as far as Scotch iron is concerned. Inquiries and orders are, however, still coming in for English and Continental irons, and there is now a strong feeling that the American demand for Scotch iron is by no means exhausted. Early this month two boats, taking about 1,100 tons between them, are due to leave Clydeside for Philadelphia and Boston, and in addition there are some heavy shipments coming on for other ports. On Tees-side the market for Cleveland iron maintains its hopeful tone, the timely American buying of the last few weeks having largely relieved the depression previously prevailing in the trade. At last week's markets, inquiries in good volume were still circularised from the United States and Canada, and it is quite anticipated that this demand will continue for some time, though perhaps in diminishing amount, despite the new tariff now in force in American ports. The pressure for export has substantially improved the demand for Cleveland iron from Scotland, where, with stocks diminishing, prices have risen well above Middlesbrough levels. The home market generally also is better, consumers having apparently made up their minds that it is useless to wait for more favourable terms. On the other hand, Midland iron is again offering at lower rates, although the quantities available are but limited. At the moment, however, makers are well sold over both October and November. In the circumstances, 95s. for prompt No. 3 is more or less nominal, but business can be done for October delivery at 92s. 6d. No. 4 foundry is firm at 90s., and No. 4 forge is obtainable at round about 85s., with mottled and white about 80s. per ton. Continental demand is very quiet.

The hematite trade continues to improve. Good sales to South Wales are reported, and business has also been done with Scotland. As regards exports, Belgium is a steady buyer, but the Continental trade generally is very patchy. Germany is still out of the market, and Italy is only taking moderate lots. Still, on the whole the volume of trade is distinctly better, and during the last week or two stocks are reported to have been substantially reduced. Quotations are correspondingly firmer, makers now demanding 90s. for East Coast mixed numbers, with a premium of 6d. per ton for the No. 1 quality. In Cumberland and North Lancashire there is a slight firming up of prices, and Bessemer mixed numbers this week are quoted for export at £5 per ton to £5 2s. 6d. per ton.

Finished Iron.

Conditions in the various sections of the finished-iron trade continue unsatisfactory, the recent renewal of active foreign competition having considerably complicated an already difficult position. This will be better realised from the fact that offers are reported in the home markets of bars of Continental origin at prices from 25s. to 30s. less than those Midland manufacturers are quoting, and it is stated that the delivery period is now less difficult than it was. South Staffordshire makers find it quite impossible to compete with such prices, claiming that when there is any profit on the iron produced it is far less than 25s., and so producers are compelled to remain idle and see these orders go abroad. Doubtless this and other matters of vital importance to manufacturers will come up for serious discussion at the forthcoming quarterly meeting, when it is suggested in some quarters that representations should be made to the Government with a view to discovering why it is that the foreigner can offer iron at so very much less than the price at which it can be produced in the principal seat of manufacture in this country. Of course, it is the commoner irons that are directly affected by this competition. Manufacturers of marked and other good-class quality bars are not so much affected by imported material, but even in that case the selling prices of their products are declared to be barely profitable, while the demand continues on a very restricted scale. The heavy cost of production explains the remarkable range of quotations for unmarked bars, and between unmarked and marked the width of the range being an indication of the peculiar conditions prevailing. There must always be a range in prices in South Staffordshire bars owing to the corresponding range in quality, but a margin of about £3 between the bottom and the top is an abnormality probably without precedent.

Steel.

Current business in steel continues on a slowly-improving scale, some districts, however, showing more expansion than others, but in the chief centre of the industry, Sheffield, demand is chiefly confined to the less expensive grades of material, the crucible quality of metal especially being exceptionally quiet. The passing by the American Senate of the Fordney Tariff Bill is a big set-back for many British manufacturers, and it remains to be seen whether rate of exchange differences between the two countries, possibly brought about by the Bill, will later re-act in such a manner as to allow English exporters to again re-enter the American market. The quick passing of the Bill has apparently caught some of the importers, and reports are current of several vessels packed with all classes of dutiable goods arriving a day or so late. As an indication of the general conditions in the home trade may be noted slightly increased activity in demand for ferro-alloys, silico-manganese being in a little better inquiry, as well as ferro-phosphorus, while the price of ferro-silicon has eased off a little in 45 per cent. grade by reason of Exchange differences, and only a moderate amount of business is passing. On the North-East Coast there is certainly more work coming forward at the steelworks, and the better feeling now in evidence will no doubt be further improved by the recent indications of some movement in the shipbuilding industry. Good inquiries for new tonnage have come to hand, and if these eventuate in orders to the local shipyards the steel trade will be correspondingly stimulated. Notwithstanding the recent improvement in trade, the steelworks of Messrs. Bolckow, Vaughan & Company, Limited, and of the Skinningrove Iron Company, Limited, still remain idle. There is no change in prices. Conditions in the tinplate market continue quiet, and the outlook by no means reassuring, while the present output is exceeding the demand. Making for stock, of course, cannot go on indefinitely, and unless a considerable improvement is shortly effected there is a prospect of many of the mills closing for want of orders. The general tone of the market is not good, and prices are "sagging" all round. So far as the basis sizes are concerned, 19s. has been accepted for spot delivery, but for October onwards 18s. 6d. has been taken, and there are now more sellers than buyers at the price. Current quotations:—Coke tins, IC 14 x 20, 112 sheets, 108 lbs., 18s. 6d. to 19s. per box; IC 28 x 20, 112 sheets, 216 lbs., 38s. 3d. to 39s. per box; lights and crosses at usual differences, net cash, f.o.b. Wales.

Scrap.

The partial improvement in the pig-iron trade recorded above is to some extent reflected in some markets for scrap material, and on Tees-side, where the works are buying a little more freely, 65s. per ton is readily paid for heavy steel scrap, of which there is a decided shortage. Heavy steel turnings and cast-iron borings are also in better demand, and with both descriptions scarce the price has hardened to round about 52s. 6d. per ton. There is a little more interest being taken in cast-iron scrap, moderate parcels of good machinery quality making from 72s. 6d. to 73s. 6d. per ton. The ordinary heavy qualities are offered at about 70s. per ton. There is a fair demand for burnt metal, for which about 55s. per ton is being paid. There is no demand at all for heavy wrought-iron scrap, the nominal prices for which are: Bushelling, 55s.; ordinary heavy piling, 60s.; special heavy forge, 70s. to 75s. per ton. All these prices are delivered works. At Glasgow, on the other hand, there has been somewhat of reduction in the quantities of steel scrap which have changed hands. This is accounted for by the unwillingness of consumers to pay 72s. 6d., and few sellers are disposed to cut their price unless for small odd lots for immediate delivery. The majority of the works are, however, in the market for supplies.

Metals.

Copper.—Movements in base metals during the past week have inclined to an appreciation of values, standard copper especially indicating a firmer tendency. The recent weakness in the copper market has been unquestionably induced by the critical position in the Near East, but it is not anticipated that the adverse conditions will continue for any length of time. The rate of domestic consumption is, however, steadily maintained, and in the United States shows a substantial increase, due to the termination of labour troubles on that side. Current quotations :—*Cash* : Wednesday, £63 7s. 6d. ; Thursday, £63 12s. 6d. ; Friday, £63 17s. 6d. ; Monday, £63 12s. 6d. ; Tuesday, £63 10s. *Three Months* : Wednesday, £63 17s. 6d. ; Thursday, £64 5s. ; Friday, £64 7s. 6d. ; Monday, £64 5s. ; Tuesday, £64 2s. 6d.

Tin.—The tone of the market for standard tin is steadily maintained, notwithstanding the ominous political outlook and a still restricted home demand. The statistical position is, however, regarded as fairly favourable, while an active buying movement on the part of American consumers is also in evidence. Producers in Banca and in China are still holding for higher prices, and practically no business is recorded from these quarters. Shipments from the Straits are not likely to exceed 5,000 tons for September, so that the end of the month returns should be satisfactory from a market point of view. Current quotations :—*Cash* : Wednesday, £160 17s. 6d. ; Thursday, £161 12s. 6d. ; Friday, £163 17s. 6d. ; Monday, £164 7s. 6d. ; Tuesday, £164 15s. *Three Months* : Wednesday, £162 2s. 6d. ; Thursday, £162 15s. ; Friday, £164 10s. ; Monday, £165 7s. 6d. ; Tuesday, £165 12s. 6d.

Spelter.—An active business has developed of late in the market for this metal, due, it may be inferred, to speculative buying on American account, that country reporting a shortage of supplies. The price has accordingly reached the highest record figure in 1920. Current quotations :—*Ordinary* : Wednesday, £32 5s. ; Thursday, £32 5s. ; Friday, £32 7s. 6d. ; Monday, £32 10s. ; Tuesday, £32 15s.

Lead.—Rather freer offerings of nearby delivery have caused a variation in the price of soft foreign pig, which registers a fall of several shillings per ton, whilst forward shipment does not show much change. The American situation continues favourable, with an excellent demand from consuming centres. Current quotations :—*Soft foreign (prompt)* : Wednesday, £24 2s. 6d. ; Thursday, £24 12s. 6d. ; Friday, £24 15s. ; Monday, £25 ; Tuesday, £25 5s.

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CENTRIFUGAL FANS

For Supplying Blast to

Cupolas and Forge Fires.

Made in a large variety of sizes and suitable for pressures up to 30-in. W.G. The Fans have cast iron casings and the belt driven type are fitted with Ball Bearings.

Send for particulars to :—

DAVIDSON & CO., LTD.,
Sirocco Engineering Works, Belfast.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.

Telegrams : "LOWOOD, DEEPCAR."

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	63	10	0
Three months	64	2	6
Electrolytic	71	10	0
Tough	66	0	0
Best selected	66	0	0
Sheets	94	0	0
India	84	0	0
Wire bars	72	5	0
Do. Oct.	72	5	0
Do. Nov.	72	0	0
Ingot bars	72	0	0
H.C. wire rods	77	0	0
Off. aver. cash, Sept. 63	3	4⅝	
Do. 3 mths., Sept. 63	12	5⅞	
Do. Settlement Sept. 63	2	11⅝	
Do. Electro, Sept. 71	3	2⅞	
Do. B.S., Sept. 67	0	0	
Aver. spot price, copper, Sept. 63	2	7½	
Do. Electro, Sept. 71	8	1	

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10½d.
Yellow metal rods 6½d.
Do. 4x4 Squares 8½d.
Do. 4x3 Sheets 9½d

BRASS.

Solid drawn tubes 11½d.
Brazed tubes 13½d
Rods, drawn 10½d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. 10d.
Wire 9½d.
Rolled metal 9½d.

TIN.

Standard cash	164	15	0
Three Months	165	12	6
English	164	0	0
Bars	166	0	0
Chinese	163	5	0
Straits	165	0	0
Australian	165	0	0
Eastern	167	0	0
Banca[1]	165	0	0
Off. aver., cash, Sept.	160	2	8½
Do. 3 mths., Sept.	160	0	7½
Do. Settlment. Sept.	160	2	3½
Aver. spot, Sept.	160	1	3¾

SPELTER.

Ordinary	32	15	0
Remelted	30	15	0
Hard	24	10	0
Electro 99.9	35	10	0
English	32	12	6
India	25	5	0
Prime Western	32	12	6
Zinc dust	48	0	0
Zinc ashes	10	10	0
Off. aver., Sept.	31	8	8[9]/[11]
Aver., spot, Sept.	31	14	10½

LEAD.

Soft foreign ppt	25	5	0
English	26	5	0
Off. average, Sept.	23	16	3[5]/[11]
Average spot, Sept.	24	2	9

ZINC SHEETS.

Zinc sheets, English	38	0	0
Do. V.M. ex. whf.	38	10	0
Dutch	38	0	0
Rods	42	5	0
Boiler plates	36	0	0
Battery plates	36	10	0

ANTIMONY.

English regulus	25	15	0
Special brands	32	10	0
Chinese	23	10	0
Crude	15	10	0

QUICKSILVER.

Quicksilver 13 2 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 12 0 0
75% 20 10 0

Ferro-vanadium—
35/40% 17/- lb. va.

Ferro-molybdenum—
70/75% 8/6 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/1 lb.

Ferro-phosphorus, 20/23%, £27

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% 1/11 lb.

Ferro-chrome—
4/6% car. £23 0
6/8% car. £22 12 6
8/10% car. £22 5

Ferro-chrome—
Max. 2% car. £55
Max. 1% car. £68
Max. 0.70% car. £75
67/70%, carbonless 1/6½ lb.

Nickel—99%, cubes or pellets £145

Cobalt metal—98/99% 12/- lb.

Aluminium—98/99% £100

Metallic Chromium—
96/98% 4/9 lb.

Ferro-manganese(net)—
76/80%, loose £15
76/80%, packed £16
76/80%, export £14 10

Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ½ in. 3d. lb.
Flats under 1 in. by ⅛ in. to ½ in. by ½ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.
Heavy Steel	3	7	6
Bundled steel & shearings	2	17	6
Mixed iron & steel	2	17	6
Heavy cast iron	3	5	0
Good machinery for foundries	3	12	6

	£	s.	d
Heavy Steel	3	12	6
Bundled steel & shearings	3	5	0
Mixed iron & steel	3	2	6
Heavy cast iron	3	15	0
Good machinery for foundries	4	0	0

Cleveland—	£	s.	d
Heavy steel	3	5	0
Steel turnings	2	10	0
Cast-iron borings	2	10	0
Heavy forge	3	12	6
Bushelled scrap	2	15	0
Cast-iron scrap	3	10	0

Lancashire—	£	s.	d
Cast iron scrap	3	17	6
Heavy wrought	3	7	6
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	56	0	0
Brass (clean)	30	0	0
Lead (less usual draft)	20	0	0
Tea lead	17	0	0
Zinc	17	0	0
New aluminium cuttings	60	0	0
Braziery copper	46	0	0
Gun metal	40	0	0
Hollow pewter	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	97/6
Foundry No. 3	95/-
Forge No. 4	85/-
Mottled	80/-
Hematite No. 1	90/6
Hematite M/Nos.	90/-
Midlands—	
Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast	240/-
„ basic	—
Northants forge 70/- to	72/6
„ foundry No. 3 77/6 „	80/-
„ basic	82/6
Derbyshire forge	75/-
„ foundry No. 3	82/6
„ basic	80/-
Scotland—	
Foundry No. 1	105/-
„ No. 3	100/-
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	82/6
„ foundry No. 3	86/6
„ basic	—
Lincs. forge	86/6
„ foundry No. 3	86/6
„ basic	86/6
E.C. hematite	101/-
W.C. hematite	102/6
All d/d in the district.	
Lancashire (d/d eq. Man.) —	
Derby forge	—
„ foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	116/6
Glengarnock foundry	118/6
Gartsherrie foundry	118/6
Monkland foundry	116/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	17	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	0	0
Bolts and nuts, ¾ in. × 4 in.	18	10	0

Steel—			
Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tees	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	15	0
Rounds, under 3in. to ¾in.	9	5	0
Flats, over 5in. wide and up	9	15	0
Flats 5in. to 1½in.	8	5	0

	£	s.	d
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	5	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ½ in. dia	12	15	0
Billets, soft	7 0 0 to 7	2	6
Billets, hard	8	0	0
Sheet bar	6 17 6 to 7	7	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 26 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	34.26
No. 2 foundry Valley	36.50
No. 2 foundry, Birm.	25.00
Basic	35.96
Bessemer	35.77
Malleable	35.96
Grey forge	37.77
Ferro-manganese 80 % delivered	75.00
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	40.00
O.-h. billets	40.00
O.-h. sheet bars	40.00
Wire rods	47.50
	Cents.
Iron bars, Phila.	2.57
Steel bars	2.00
Tank plates	2.25
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.60
Plain wire	2.35
Barbed wire, galv.	3.15
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/- to 40/-
„ furnace	30/- to 32/6
Durham & North. foundry	28/-
„ furnace	23/6
Other Districts, foundry	27/6
„ furnace	22/-

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

Rolled Ordinary— Assortment ..	£ 17 s. 10 d. 0
Nail Rods— Square, round and flats ..	to 18 0 0
Keg Steel	nom. £38 to £40
Faggot Steel	nom. £30 to £32
Blooms— Single welded ..	£10 to £11
Billets— Single and double welded	£13 to £14
Pig-Iron— Grey, white or mottled ..	£7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	55%	Tube prices are now free.
Water	50%	
Steam	45%	

TINPLATES.

I.C. Cokes,	20×14,	box	18/9
,,	28×20,	,,	38/3
,,	20×10,	,,	27/7½
,,	18¾×14,	,,	19/1½
I.X.		,,	44/–
I.X.X.		,,	51/–
F.C.B.Y.	21×13½	,,	36/6
C.V.B.G.	16¾×15,	,,	35/–
I.C.W.	20×14,	,,	16/7½
,,	28×20,	,,	33/6
,,	20×10,	,,	22/7½
,,	18¾×14,	,,	17/1½
Terneplates,	28×20,	,,	34/6

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Sept. 27	63	7	6	inc.	5/–
,, 28	63	12	6	,,	5/–
,, 29	63	17	6	,,	5/–
Oct. 2	63	12	6	dec.	5/–
,, 3	63	10	0	dec.	2/6

Electrolytic Copper.

Sept. 27	71	5	0	No change	
,, 28	71	10	0	inc.	5/–
,, 29	71	10	0	No change	
Oct. 2	71	10	0	,,	
,, 3	71	10	0	,,	

Standard Tin (cash).

Sept. 27	160	17	6	dec.	7/6
,, 28	161	12	6	inc.	15/–
,, 29	163	17	6	,,	45/–
Oct. 2	164	7	6	,,	10/–
,, 3	164	15	0	,,	7/6

Tin (English ingots)

Sept. 27	161	0	0	dec.	5/–
Sept. 28	161	15	0	inc.	15/–
,, 29	163	7	6	,,	42/6
Oct. 2	164	0	0	,,	12/6
,, 3	164	10	0	,,	10/–

Zinc Sheets (English).

Sept. 27	37	10	0	No change	
,, 28	37	10	0	,,	
,, 29	37	10	0	,,	
Oct. 2	38	0	0	inc.	10/–
,, 3	38	0	0	No change	

Spelter (ordinary).

Sept. 27	32	5	0	No change	
,, 28	32	5	0	,,	
,, 29	32	7	6	inc.	2/6
Oct. 2	32	10	0	,,	2/6
,, 3	32	15	0	,,	5/–

Lead (English).

Sept. 27	25	19	0	inc.	5/–
,, 28	26	0	0	,,	10/–
,, 29	26	0	0	No change	
Oct. 2	26	0	0	,,	
,, 3	26	5	0	inc.	5/–

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